Survey of Selected Streams for Sensitivity to Acidification from the Proposed Hat Creek Coal Development

J.A. Servizi, R.W. Gordon, S.C. Samis, L.G. Pella,
M.A. Sullivan, and M.D. Nassichuk

Habitat Management Division
Field Services Branch
Department of Fisheries and Oceans
1090 West Pender Street
Vancouver, B.C. V6E 2P1

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SURVEY OF SELECTED STREAMS FOR SENSITIVITY TO ACIDIFICATION FROM THE PROPOSED HAT CREEK COAL DEVELOPMENT

by

J.A. Servizi and R.W. Gordon

Environment Conservation Division
International Pacific Salmon Fisheries Commission
P.O. Box 30
New Westminster, B.C. V3L 4X9

S.C. Samis, L.G. Pella, M.A. Sullivan, and M.D. Nassichuk

Habitat Management Division
Field Services Branch
Department of Fisheries and Oceans
1090 West Pender Street
Vancouver, B.C. V6E 2P1

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ABSTRACT

Servizi, J.A., R.W. Gordon, S.C. Samis, L.G. Pella, M.A. Sullivan, and M.D. Nassichuk. Survey of selected streams for sensitivity to acidification from the proposed Hat Creek coal development. Can. Tech. Rep. Fish. Aquat. Sci. 1389: vi + 76 p.

Thirty-two Pacific salmon streams located downwind of the proposed B.C. Hydro coal-fired electric generating plant at Hat Creek (south central British Columbia) were sampled for pH, alkalinity and metals between 1981 and 1983. Eight of the streams sampled were found to have alkalinities below 200 $ueq \cdot L^{-1}$ for part of the year, including: Blue River, Boss Creek, Crazy Creek, Crooked Creek, Finn Creek, Raft River, Seymour River and Adams River (above Adams Lake). The pH and alkalinity values of two rivers (Raft and Eagle) during snowmelt were depressed coincident with spring freshet. Buffer capacities ($ueq \cdot L^{-1} \cdot pH^{-1}$) were calculated for 14 streams with low alkalinities.

RÉSUMÉ

Servizi, J.A., R.W. Gordon, S.C. Samis, L.G. Pella, M.A. Sullivan, and M.D. Nassichuk. Survey of selected streams for sensitivity to acidification from the proposed Hat Creek coal development. Can. Tech. Rep. Fish. Aquat. Sci. 1389: vi + 76 p.

Entre 1981 et 1983, on a prélevé des échantillons d'eau dans 32 cours d'eau fréquentés par des saumons du Pacifique et situés sous le vent par rapport à l'endroit prévu pour le projet de centrale thermique au charbon de B.C. Hydro à Hat Creek (centre-sud de la Colombie-Britannique) afin de déterminer le pH, l'alcalinité et la présence de métaux. On a trouvé que 8 des cours d'eau échantillonnés, soit la rivière Blue, le ruisseau Boss, le ruisseau Crazy, le ruisseau Crooked, le ruisseau Finn, la rivière Raft, la rivière Seymour et la rivière Adams (en amont du lac Adams) avaient une alcalinité inférieure à 200 ueq/L pendant une partie de l'année. Les valeurs de pH et d'alcalinité de deux rivières (Raft et Eagle) au cours de la fonte des neiges étaient réduites, coincidant avec les crues printanières. On a calculé le pouvoir tampon (ueq/L/pH) de 14 cours d'eau qui présentaient une faible alcalinité.

INTRODUCTION

This study was initiated in response to an April 1981 Environmental Impact Statement (EIS) by the British Columbia Hydro and Power Authority (BCHPA). The EIS was produced pursuant to a BCHPA proposal to develop a coal-fired thermal electric power generating station in the Hat Creek valley of south central British Columbia.

The Hat Creek project initially involved development of a power plant with a 2,000 megawatt generating capacity. A total of 336 million tonnes of coal was to be open-pit mined, to be consumed at a maximum rate of 40,500 tonnes per day by the power plant.

The environmental concerns associated with the burning of fossil fuels include the chemically transformed end products of gaseous emissions of sulphur and nitrogen oxides which, following atmospheric transport, can result in acidic dry and wet depositions downwind. The extent of environmental impact from these depositions is dependent upon factors such as:

a) Emission volume and quality.
b) Emission dispersion characteristics.
c) Atmospheric processes leading to chemical transformation.
d) Existing precipitation quality and quantity, and
e) The alkalinities of the receiving environment (surface and groundwaters, soils, vegetation, and underlying bedrock).

Numerous studies have documented the impacts of surface water acidification on aquatic biota (Schofield 1976; Muniz and Leivestad 1980a; Harvey et al. 1981). Investigations conducted with fish indicate that all phases of their life cycles, particularly the reproductive and early developmental stages, can be adversely affected by acidification (Beamish and Harvey 1972; Mount 1973). In addition to direct toxicity, acid precipitation can reduce ground and surface water pH thus mobilizing toxic heavy metals, such as aluminum, in receiving waters and adversely affecting the survival and development of fish and other aquatic life (Baker 1981).

In 1982 BCHPA indefinitely postponed the proposed Hat Creek project.

This report presents the results of a background water chemistry program conducted by the Department of Fisheries and Oceans and the International Pacific Salmon Fisheries Commission from June 1981 to March 1983. This program was initiated in response to concerns about the sensitivity of surface waters that could receive acidic depositions from the Hat Creek project. Alkalinity, pH, metals and a number of other chemical parameters

were examined in selected watercourses that are known to support important fisheries resources. A limited number of snow samples were also obtained and analyzed for pH, conductivity, sulfate, nitrate, ammonium and chloride content.

STUDY AREA

The prevailing wind in the Hat Creek area is from the southwest. Surface water and snowpack sampling sites were selected in areas to the east and northeast of the proposed development site. Due to the elevation (1410 m) of the intended plant site and the proposed stack height (244 m), the receiving area for the emissions could be extensive. Within this broad geographic area, the streams and lakes investigated provide important spawning, rearing and migratory habitat for Pacific salmon (Figure 1).

Figure 2 identifies the major salmon spawning watercourses of the Fraser and Thompson River systems. The salmon escapements and juvenile utilization for the Thompson River are summarized by sub-basin in Table 1 (Knapp et al. 1982). Because of its importance as a salmon-bearing waterway, the Fraser River watershed (including its major tributary, the Thompson River) was selectively monitored.

Sites for snowpack sampling were selected in conjunction with established surface water sampling sites in order to investigate the "response" of surface water quality to receipt of snowmelt (Figure 1).

The location of sampling sites for water and snow are detailed in Appendix 1.

MATERIALS AND METHODS

SAMPLING FREQUENCY

Watercourses in the study area were sampled during eight field trips conducted between June 1981 and March 1983. This report includes data obtained during the following periods:

Period	Conditions
June 1978	preliminary surveys
Apr-May 1981	preliminary surveys
June 1981	freshet
Oct 1981	post-freshet
Mar 1982	low flow; snow sampling
Apr 1982	pre-freshet
June 1982	freshet
Apr-June 1982	weekly sampling of Eagle & Raft Rivers during freshet
Mar 1983	low flow; snow sampling

SURFACE WATER SAMPLING

Thirty-two watercourses were sampled between June 1981 and March 1983. Based on early results, watercourses with alkalinities greater than 600 microequivalents per litre ($ueq \cdot L^{-1}$) (30 $mg \cdot L^{-1}$ $CaCO_3$) were deleted from subsequent samplings to allow emphasis on watercourses with less alkalinity.

Field Methods

For watercourses, surface grab samples for pH, sulfate, ammonia, nitrate, chloride, alkalinity and conductivity were collected in new 200 mL or 1 L polyethylene bottles. Bottles were triple-rinsed with the sample water before filling. Samples were collected by holding the container just under the water surface with care being taken to exclude air. The filled bottles were stored on ice in the field and refrigerated upon receipt at the laboratory, prior to analysis.

As pH may vary considerably with time, analyses should be performed as soon as possible after collection (Government of Canada 1979). However, due to the duration of most field trips, at least one week usually elapsed before samples could be delivered to the laboratory. A test was therefore conducted to examine the extent of pH change during storage. Eleven pairs of 1 L samples were collected; one was transported immediately by bus to the laboratory where analyses of pH, alkalinity and conductivity were usually conducted within 24 hours. The other sample was held on ice in the field until the return trip to the

laboratory. Analyses of the second set of samples were usually conducted within 7 days of field collection.

Samples were also collected weekly between April and July, 1982 at the Eagle and Raft River sites. These samples were transported immediately to the laboratory and analyses were usually conducted within 24 hours of collection.

Dissolved, extractable and total metal contents of the samples were measured. The "dissolved" component is that portion which passes through a 0.45 um filter and is brought into solution by the addition of acid to the filtrate. It is considered to be the "biologically reactive" portion.

Samples for dissolved metal analyses were collected using a 60 mL disposable plastic syringe and filtered into 100 mL acid washed polyethylene bottles containing 0.25 mL of concentrated nitric acid. The filtering assembly consisted of a 60 mL syringe (B-D 5663) and a disposable, small-volume filtering unit pre-fitted with a 0.45 um sterile membrane filter (Gelman Acrodisc 4184). The syringe and filtering unit were equipped with complementary Luer-Lok connections. The syringe was triple-rinsed with sample water prior to sample collection. Sixty mL of sample were drawn and the syringe secured to the filtering unit. Ten mL of sample water were filtered and discarded to rinse the filter. The remaining 50 mL of sample were filtered into the sample bottle.

The "extractable" component of metals from an unfiltered acid-treated (partial acid digestion) sample included the dissolved metals fraction plus metals lightly adsorbed to any particulate matter. In theory this component is a good indication of the portion that could potentially become biologically available should rapid acidification occur.

The "total" component of metals from an unfiltered, acid-treated (thorough hot acid digestion) sample included both the dissolved metals and the particulate matter brought into solution.

Samples for total and extractable metals and hardness analyses were collected in 200 mL acid washed polyethylene bottles, to which 1 mL concentrated nitric acid was added as a preservative. Samples were taken approximately 15 to 30 cm below the water surface.

Analytical Methods

Analyses for pH, alkalinity and conductivity were performed at the IPSFC Sweltzer Creek Laboratory (Cultus Lake, B. C.). Alka-

linity and pH were determined using a Radiometer pH meter (model 61) equipped with dual electrodes. Conductivity was measured using an Industrial Instruments Conductivity Bridge conductivity cell (Model R.C.-1). Potentiometric titrations were stopped at pH 4.2 in the 1981 samples, but thereafter continued to pH 3.2 to complete the titration curves, using 0.02 N hydrochloric acid. Titration curves are not presented in this report but data are on file in the Sweltzer Creek Salmon Research Laboratory, International Pacific Salmon Fisheries Commission. Total alkalinity was calculated according to the "low alkalinity" procedure (APHA 1980):

$$\text{Total alkalinity } (mg \cdot L^{-1}\ CaCO_3) = \frac{(2B - C)\ N\ 50{,}000}{mL \text{ of sample}}$$

where: B = volume of acid to pH 4.5
C = total volume of acid to pH 4.2
N = normality of acid.

Analyses for metals (total, extractable, and dissolved), hardness and other ions ($SO_4^=$, NH_3, NO_3^-, Cl^-) were performed by the Environmental Protection Service/Department of Fisheries and Oceans (EPS/DFO) Chemistry Laboratory (West Vancouver, B. C.). Samples for metals and hardness were analyzed within 2 weeks. Samples of other ions (sulfate, nitrate-N, ammonia-N, and chloride) were kept refrigerated and were analyzed after a maximum storage time of 9 days.

The methods of analysis and the instrument detection limits are summarized in Table 2. A change in instrumentation in mid-1982 improved the detection limit for metals.

SNOWPACK SAMPLING

Late winter snowpack sampling was undertaken in March of 1982 and 1983. Three replicates were collected from each of six sites in 1982, whereas two replicates from each of five sites were collected in 1983. All sites were within the drainage basin of streams included in the surface water sampling program and were considered representative of the local forested area. To eliminate the possibility of reduced hydrogen and nitrate ion content from "throughfall effects" (Johannes et al. 1980), snow was collected outside the "drip line" of the surrounding vegetation. The sample sites were removed from any obvious sources of contamination. Samples were collected from areas exhibiting a similar snow depth.

Field Methods

The snow sampler (20 L volume) was a clear acrylic, hollow half-cylinder, 1 m in height with a radius of 80 mm (Figure 3).

The sampler was first "rinsed" by collecting and discarding three snow cores. Representative samples were then collected for analysis.

Sampling was conducted from a pit in the snow which had been excavated to ground level. The sampler was pushed vertically into the snowpack just beyond the exposed face of the pit. An acrylic partition (1m x 0.16m) was then inserted into the track at the open edge of the half-cylinder (Figure 3). An acrylic cap placed at the lower end of the sampler allowed the contents to be retrieved intact. The snow sampler was then removed by digging away the surrounding snow. The bottom few centimetres of sample were discarded if organic debris was evident. The snowcore was stored in a pre-rinsed polyethylene pail with an airtight lid.

When the snowpack was deeper than 1 m, additional cores were taken to complete the vertical profile. At sites where snow depth was less than 0.7m, several cores were combined to obtain an adequate volume for analytical purposes.

Disposable plastic gloves were worn by field personnel during sampling to avoid contamination of the sample. Samples were kept frozen during delivery to the IPSFC laboratory and until analyses could be performed.

Analytical Methods

The snow samples were thawed in the sealed pails in a circulating warm water bath. The meltwater was analyzed immediately for pH and conductivity. The remaining meltwater was immediately transferred to appropriate sample bottles for subsequent analyses of metals and other consitutents as described under Analytical Methods for surface water samples.

RESULTS AND DISCUSSION

PH AND ALKALINITY

To determine the effects of sample storage time on pH, alkalinity and conductivity, 11 sample pairs were compared for the sites and dates listed below.

Adams Lake	June 09/82
Adams River (above lake)	June 09/82
Boss Creek	March 03/82, March 30/82
Crazy Creek	June 10/82
Eagle River	June 10/82
Hendrix Lake	March 03/81, March 30/82
Horsefly River	March 30/82
Raft River	June 09/82
Seymour River	June 10/82

For pH, values decreased for 8 of the stored samples, were unchanged for two and increased 0.01 pH units for one (Table 3a). The mean departure from the pH of the samples analyzed within 24 hours was 0.05 units, equivalent to 0.74 percent. Alkalinity decreased for 7 of the stored samples, was unchanged for one and increased for three (Table 3a). The mean change from the alkalinity of the samples analyzed with 24 hours was 1.73 percent. Conductivity decreased for four of the stored samples, increased for five and was unchanged for two. The mean difference between conductivity values for samples analyzed within 24 hours and those stored was 1.69 percent. These departures from values for samples analyzed within 24 hours were considered acceptable for this survey.

The pH values for the watercourses sampled ranged from 6.5 to 8.2 (Table 3a) and are in the normal range expected for surface waters. The alkalinities ranged from 117.6 to 3661.6 $ueq \cdot L^{-1}$ (Table 3a) and reflect the wide range of buffering capacities associated with the soils and geochemistry of the area (Wiens 1984).

Alkalinity has been commonly used to define susceptibility of a lake or stream to acid deposition (Glass *et al.* 1982). In an earlier review, it was concluded that lakes with less than 300 $ueq \cdot L^{-1}$ alkalinity were susceptible to acid deposition (Glass *et al.* 1979). Clark and Bonham (1982) classified sensitivity of surface waters of British Columbia to acid deposition into six categories according to alkalinity. Class A consisted of waters with alkalinities of 200 $ueq \cdot L^{-1}$ or less while class B fell between 200 and 400 $ueq \cdot L^{-1}$. Classes A and B were considered to have inadequate buffering to ensure protection against acid deposition.

Eight watercourses in the Hat Creek study area had alkalinities of 200 ueq·L^{-1} and less, at least part of the year (Table 3a). These were: Blue River, Boss Creek, Crazy Creek, Crooked Lake, Finn Creek, Raft River, Seymour River and Adams River (above Adams Lake). Adams Lake, Eagle River, Hendrix Lake, Horsefly River, Momich River and North Barriere River had alkalinities less than 400 ueq·L^{-1} part of the year. Minimum alkalinities typically occurred in June. The effects of spring freshet on alkalinity and pH were documented with weekly samples from the Eagle and Raft rivers in April, May and June (Figures 4 and 5). Alkalinity and pH declined to minimums in June as river flows increased due to the inflow derived from melting snowpacks at high elevations. Such decreases in pH and alkalinity are expected since snowmelt water typically has lower pH and more acidity than groundwater, which supplies much of the river water the remainder of the year.

Depression of pH coincident with snowmelt is consistent with the findings of others (Schofield and Trojnar 1980; Overrein et al. 1980; La Zerte 1984). Accumulations of dry or wet acid depositions in snowpacks during winter increase the potential to lower pH and alkalinity of watercourses during the subsequent freshet.

BUFFER CAPACITY

It is common practise to use alkalinity, frequently referred to as buffering capacity, to classify the sensitivity of natural waters to acidification. Alkalinity is a measure of the capacity of a water to neutralize a specific quantity of acids. On the other hand, buffer capacity (Faust and McIntosh 1983) combines alkalinity and pH of a water in a calculation to define resistance to pH change (Faust and Aly 1981; Faust and McIntosh 1983). Resistance to pH increase is a positive (+) number, resistance to pH decrease is a negative (-) number. The smaller the numerical value the less resistance there is to change. Simply put, if two waters have identical alkalinities, the one with the lower pH will have the greater buffer capacity, that is, it has more resistance to decrease in pH. Thus when assessing resistance of waters to acid deposition it is appropriate to calculate buffer capacities. Accordingly, the buffer capacities of the eight watercourses with alkalinities of 200 ueq·L^{-1} or less were calculated coincident with minimum alkalinities (Table 3a).

The eight watercourses with alkalinities less than 200 ueq·L^{-1} are ranked below according to increasing buffer capacity and alkalinity. It is evident that the rankings differ under alkalinity and buffer capacity.

Buffer capacity $ueq \cdot L^{-1} \cdot pH^{-1}$		Alkalinity $ueq \cdot L^{-1}$	
Crooked Lake	-73.2	Finn Creek	117.6
Finn Creek	-87.9	Raft River	125.4
Adams River (upper)	-89.4	Boss Creek	131.4
Blue River	-89.8	Crooked Lake	132.0
Seymour River	-94.9	Seymour River	142.0
Raft River	-104.0	Blue River	151.8
Crazy Creek	-113.0	Adams River (upper)	176.4
Boss Creek	-150.0	Crazy Creek	196.0

The use of buffer capacity in calculation of pH change due to acid input can be illustrated by hypothetical examples. Assume net acid inputs of 5 $ueq \cdot L^{-1}$ due to acid deposition to waterbody A and waterbody B with buffer capacities of -70 and -120 $ueq \cdot L^{-1} \cdot pH^{-1}$, respectively. The calculated reduction in pH would be:

Waterbody A

$$\Delta \text{ pH} = \frac{5}{-70} = -.07$$

Waterbody B

$$\Delta \text{ pH} = \frac{5}{-120} = -.04$$

To estimate the long term effect of net acid input to a waterbody the seasonal variability of buffer capacity must be taken into account. Furthermore, since buffer capacity is pH dependent, new values of buffer capacity should be calculated for successive decreases in pH. Because of the dependence of buffer capacity on pH, it is recommended that pH changes derived from the titration curve for the waterbody and from buffer capacity be compared when acid inputs exceed ten percent of buffer capacity.

HARDNESS, NITRATE, SULFATE, AMMONIA

Hardness ranged from 6.82 $mg \cdot L^{-1}$ in Finn Creek to 137 $mg \cdot L^{-1}$ in Loon Creek (Table 3b). The maximum value of nitrate nitrogen was 0.43 $mg \cdot L^{-1}$, equal to 1.90 $mg \cdot L^{-1}$ nitrate, and occurred in Boss Creek. Surface waters rarely contain as much as 5 $mg \cdot L^{-1}$ nitrate and are often less than 1 $mg \cdot L^{-1}$ (McNeely *et al.* 1979). Maximum sulfate was 23.3 $mg \cdot L^{-1}$ and also occurred in Boss Creek. All values of sulfate were in the low range for natural waters (McNeely *et al.* 1979). The maximum value of ammonia nitrogen was 0.02 $mg \cdot L^{-1}$, equal to 0.025 $mg \cdot L^{-1}$ ammonia, in Hendrix Lake. This concentration is well within the value of 1 $mg \cdot L^{-1}$ total ammonia specified for waters supporting salmonids (Haywood 1983).

SURFACE WATER METALS

There was wide variation in the occurrence and concentration of total metals and various trace elements in the surface waters (Appendix II). Total Ca was the major constituent. Total Al, Ba, Fe, Mg, Mn, Na, Si, Sr, and Ti were consistently present above detection limits. The occurrence of Cr, Cu, Zn, Ni, Pb, Sb, and Se were sometimes above detection limits. Total As, Cd, Ca and V rarely occurred above detection limits.

Analyses for dissolved metals were only performed on the 15 samples collected in March 1983. Typically, each metal detected in the "total" form was also detected in the dissolved state, except for aluminum. Dissolved Al was detected in only 5 of 11 samples. This is not unexpected since aluminum is commonly combined with other elements comprising clay and other minerals. The dissolved aluminum content of natural waters is rarely greater than 0.5 $mg \cdot L^{-1}$ (Faust and Aly 1981). The highest value of dissolved aluminum reported herein is 0.10 $mg \cdot L^{-1}$ in Boss Creek. This latter value equals the guideline proposed for protection of aquatic life (McNeely et al. 1979).

As waters become acidified, metals may be released from natural chelating agents and become biologically available (Muniz and Leivestad 1980; Schofield and Trojnar 1980). Aluminum is of particular concern since it is widely distributed in natural waters, including those in this survey, and may become toxic as speciation changes with pH. The uncomplexed Al^{3+} and the hydroxy ion species are toxic to fish while the Al-F ion and Al combined with organic complexing agents are not (Driscoll et al. 1980). The biological reactivity of aluminum is dependent on pH, the concentration of other cations such as calcium and the amounts of organic complexing agents such as humic acids (Hendershot et al. 1984).

Dissolved aluminum represents the amount that is biologically available, whereas total aluminum includes unavailable bound forms. Total aluminum is the source from which additional biologically available aluminum may be derived as pH decreases. As noted above, most of the aluminum detected in this survey was in the bound state; dissolved aluminum was detected in only five of 11 samples tested, and occurred in amounts within the proposed guideline for aquatic life.

SNOWMELT

Snow meltwater pH ranged from 4.9 to 5.9 (Tables 4a, 5). The lower values occurred near Finn Creek and Horsefly River in March, 1982. When snow was collected from the Horsefly River site in March, 1983 the meltwater pH was 5.6. The upper values

of meltwater pH occurred near Blue River in March, 1983. Precipitation is considered acidic if the pH is below 5.6, the normal equilibrium value of carbon dioxide in water (Likens et al. 1979). The reasons for the high and low values of pH of snow samples were not apparent. The snow sampling sites were remote from major population or industrial centers. However, snow samples were collected from river valleys and thus may have received acidic and/or alkaline inputs from local sources.

The sulfate content of snow meltwater was in the range 1.3 to 2.2 $mg \cdot L^{-1}$ (Table 4b). These values are similar to the means of 0.93, 2.25 and 2.88 $mg \cdot L^{-1}$ reported for snow from the Sierra Nevada, Utah and Denver, Colorado areas (Faust and Aly 1981). These authors also reported mean chloride concentrations of 0.50, 0.97 and 1.60 $mg \cdot L^{-1}$ for the foregoing sites. In this study, chloride ranged from non-detectable to 0.8 $mg \cdot L^{-1}$. In another study the average sulfate content of snow samples from southwestern B.C. ranged from less than 0.2 to 0.6 $mg \cdot L^{-1}$ (McLaren 1982). This author also reported mean chloride from less than 0.2 to 0.5 $mg \cdot L^{-1}$. Nitrate ranged from 0.22 to 0.93 $mg \cdot L^{-1}$ in the areas downwind of Hat Creek (Table 4b). The mean nitrate contents of snow samples reported for southwestern B.C. were from 0.115 to 0.483 $mg \cdot L^{-1}$ (McLaren 1982). The mean nitrate content of rain water at Tacoma, Washington was 0.99 $mg \cdot L^{-1}$ (Faust and Aly 1981). The ammonium content of snow ranged from 0.009 to 0.039 $mg \cdot L^{-1}$. McLaren (1982) reported mean ammonium values between 0.013 and 0.101 $mg \cdot L^{-1}$. Thus chloride and ammonium contents of snow downwind of Hat Creek were similar to amounts reported for southwestern B.C. However, the sulfate and nitrate contents of snow reported herein were greater than values reported for snow in southwestern B.C., but similar to values reported for snow and rainwater elsewhere. The reason for the differences are not apparent but may relate to local inputs.

Iron was present above the detection limit in all snow samples while Mn, Ba and Ti were less frequently above detection limits. (Appendix 3).

CONCLUSIONS

The data collected in this study indicate that there are watercourses susceptible to the detrimental effects of acidic deposition downwind of the Hat Creek area. The buffering capacities of these waters are considered resources to be protected. Sensitivity of streams to acidification must be considered in the assessment of any new development with the potential to result in acidic deposition.

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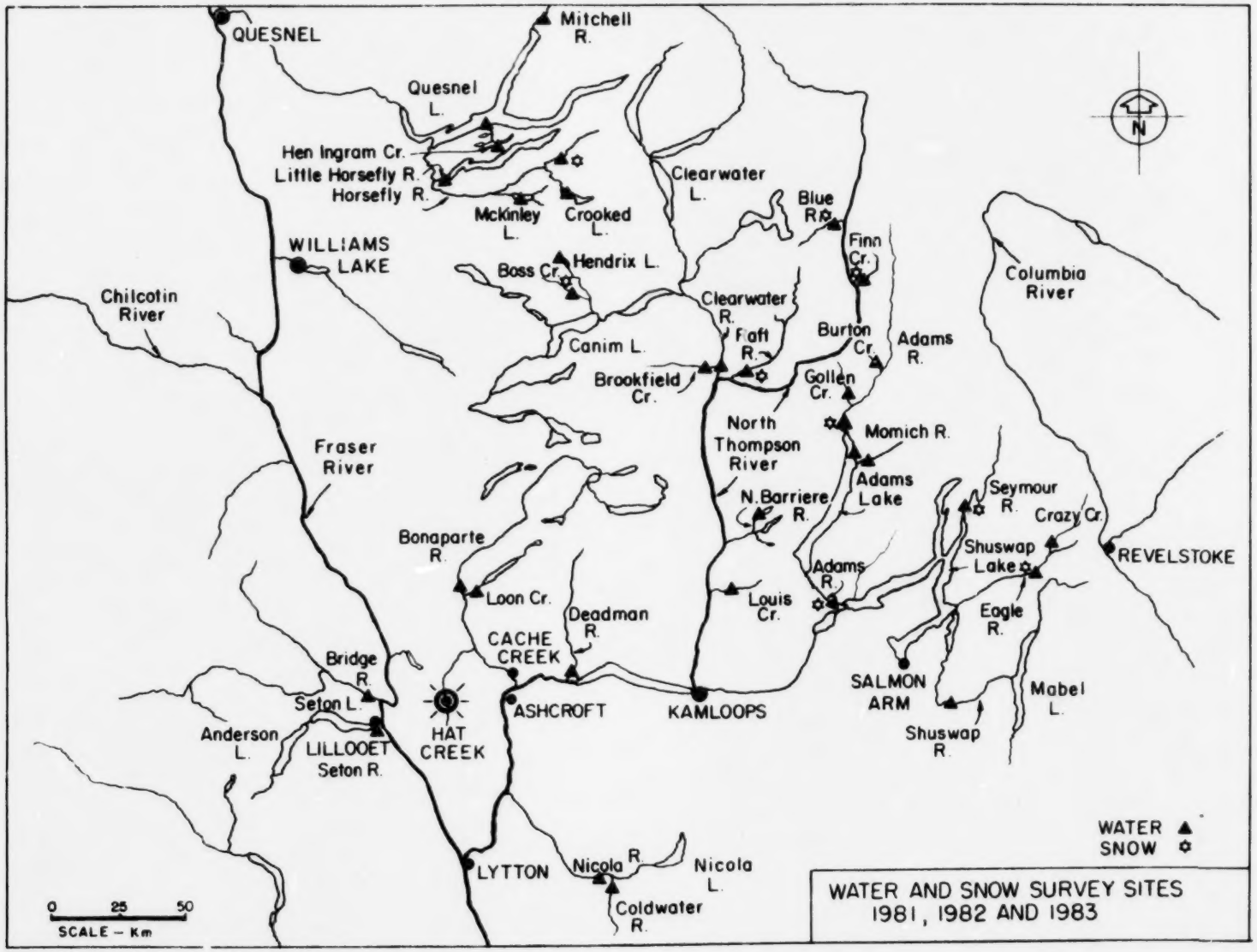

Figure 1

Surface water and snowpack sampling locations

Figure 2
Fisheries resources of study area

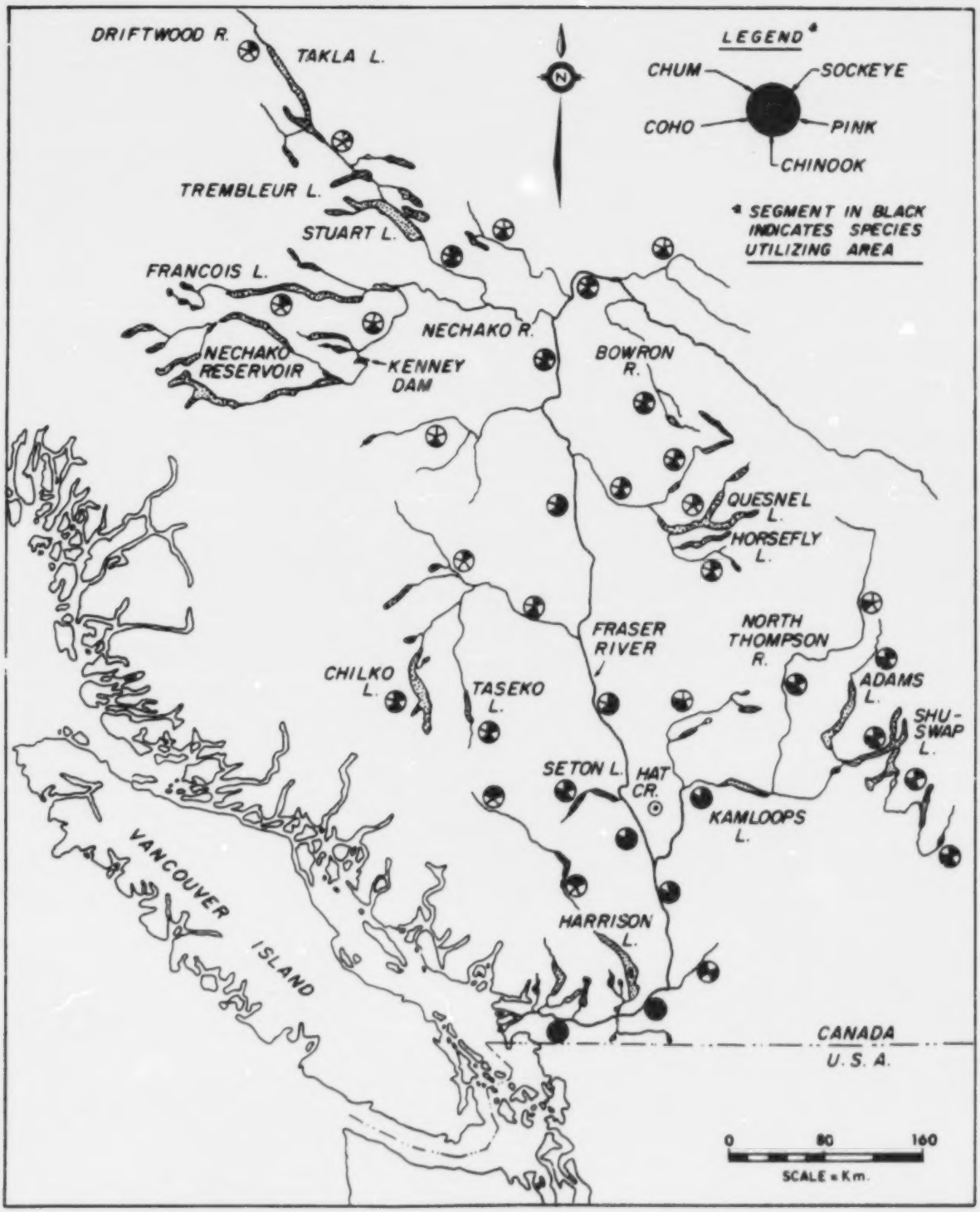

Figure 3
Snowpack sampler

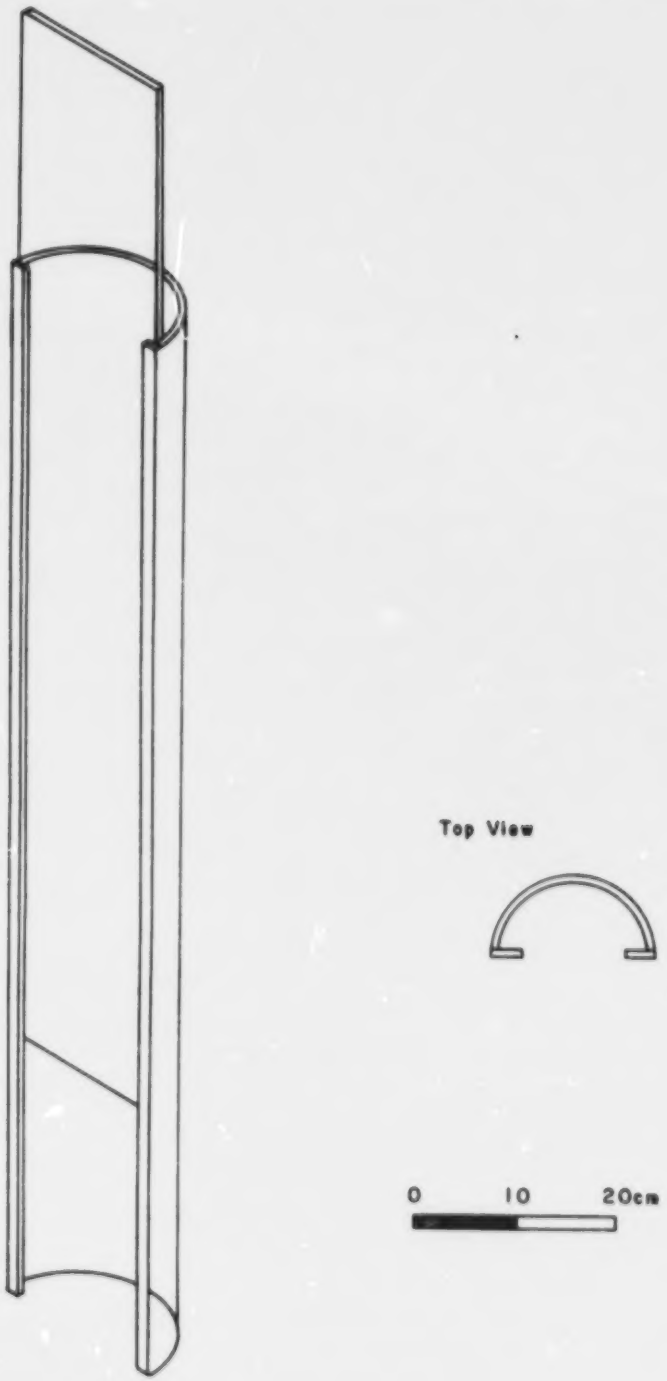

Figure 4
Weekly pH and alkalinity for Eagle River during freshet, 1982 and corresponding hydrograph.

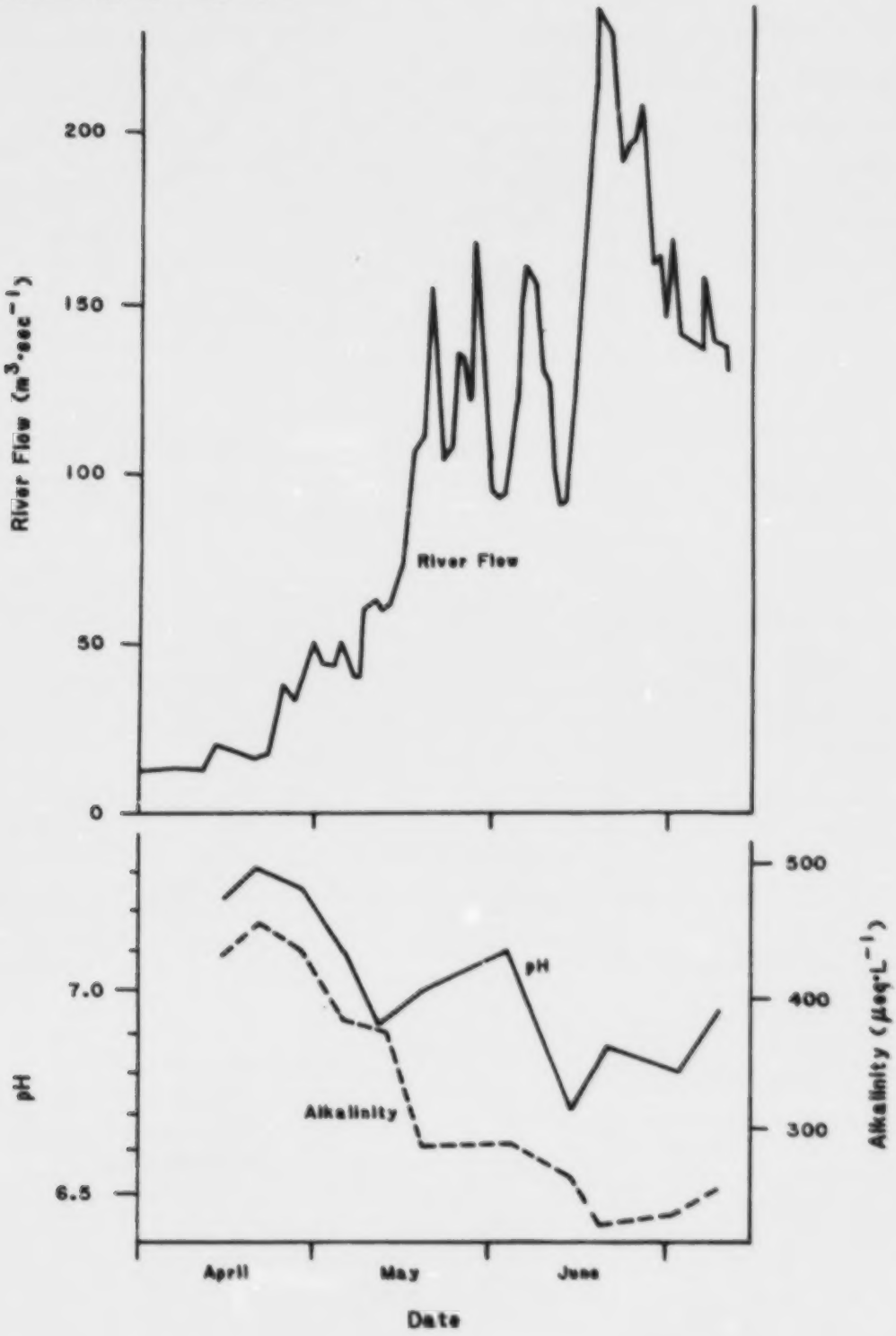

Figure 5
Weekly pH and alkalinity for Raft River during freshet, 1982 and historic (1914 - 1957 monthly averages) hydrograph.

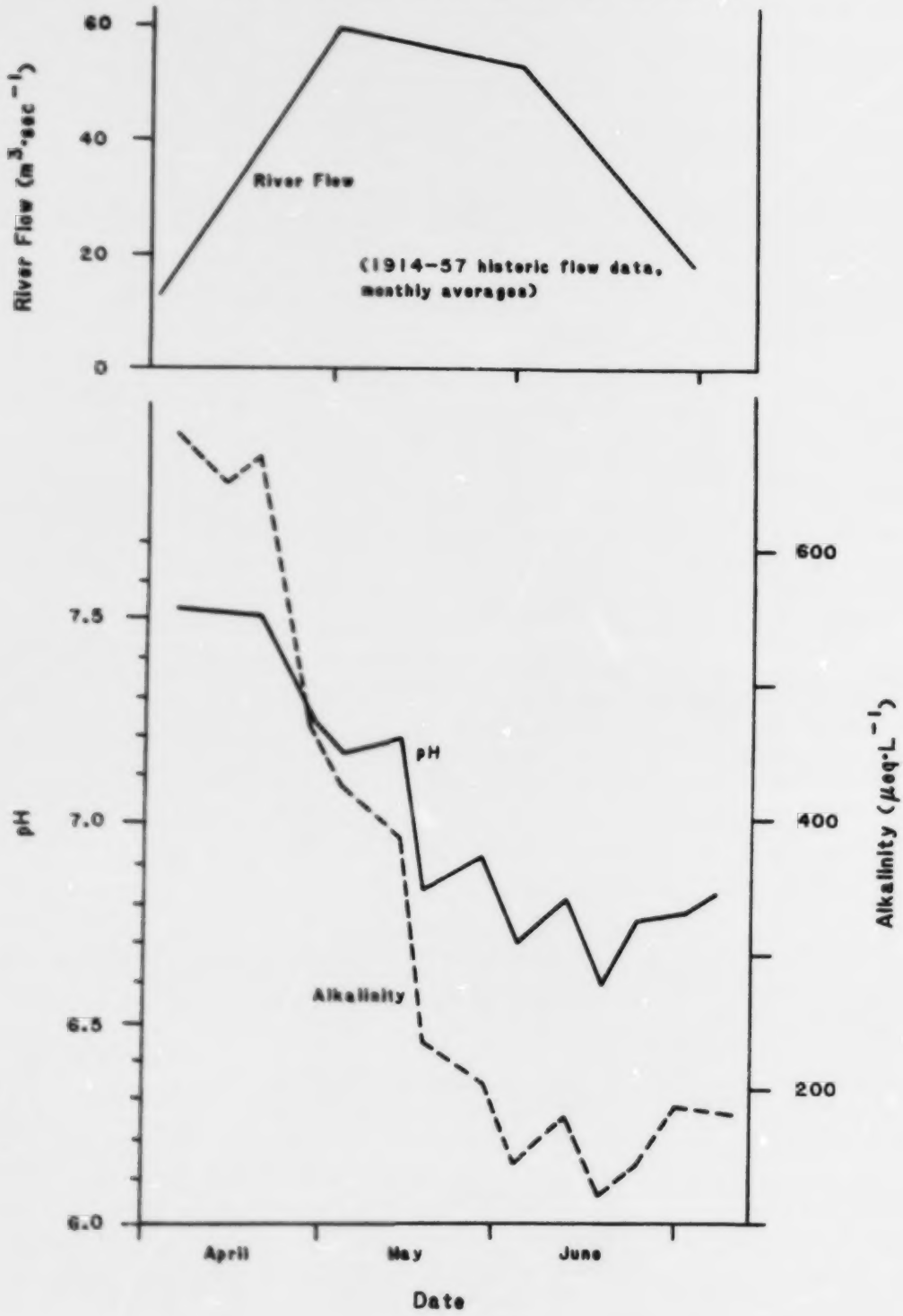

Table 1 - Thompson River Basin Salmon Escapements and Juvenile Production
(from Knapp et al. 1982)

	Thompson Sub-Basin		North Thompson Sub-Basin		South Thompson/Shuswap Sub-Basin		TOTAL	
	Escapement (x1,000)	Juveniles (x10,000)	Escapement (x1,000)	Juveniles (x10,000)	Escapement (x1,000)	Juveniles (x10,000)	Escapement (x1)	Juveniles (x100,000)
Chinook								
Average	2.6	1.9 (0+)[a]	4.6	38.1 (0+)	16.5	200 (0+)	27200	240 (0+)
		7.3 (1+)[b]		4.5 (1+)		2.0 (1+)		1.38 (1+)
Maximum	4.3	3.2 (0+)	7.4	61.4 (0+)	25.7	310 (0+)	37400	370 (0+)
		12.1 (1+)		7.3 (1+)		3.1 (1+)		2.25 (1+)
Coho								
Average	0.3	0.45	9.1	13.7	5.5	8.25	14900	2.24
Maximum	0.325	0.49	11.4	17.1	7.9	11.9	19600	2.949
Pink								
Average 1969/71/73/75/77	408.5	5300	0.15	1.95	0.45	5.85	409100	530
Maximum	970.1	17800	-	-	4.1	53.3	974200	1700
Sockeye								
Average	-	-	5.9	49.6	550.5	4620	556400	467
Maximum	-	-	13.6	114	1966.5	16400	1980100	
Cycle Averages								
1969/73/77	-	-	3.675	31.0	74.7	624	78375	65.5
1970/74/78	-	-	3.55	29.5	1580.0	13300	1583550	1330
1971/75	-	-	4.95	41.6	257.475	2160	262425	220
1972/76	-	-	13.5	113	12.075	101	25575	21.4

Figures for the Nicola River Sub-Basin are not included (average annual escapements, 1960 to 1978 are 2100 coho, 3800 chinook and 750 pink). Averages have been rounded off and cover the 1969 to 1978 period unless otherwise indicated. Juvenile production estimates are based on SEP design criteria for average percent survival (Canada, DFO, SEP, 1981). The North Thompson pink escapement is for 1977. 835 pinks were recorded in 1979.

[a] 0+ - fry that are newly emerged to one year old.
[b] 1+ - fry that are between one and two years old.

Table 2 - Methods of Analysis and Detection Limits for Water and Snow Chemistry Samples

	Method of Analysis	Detection Limits 1981	Detection Limits 1982/83[a]	Units	
pH	Potentiometric analysis	0-14	0-14		
Total Alkalinity	Potentiometric titration	-	-	$ueq \cdot L^{-1}$	$CaCO_3$
Hardness	Sum of $CaCO_3$ equivalent concentrations of hardness producing cations (Ca & Mg)	0.1	0.1	$mg \cdot L^{-1}$	$CaCO_3$
Conductivity	Conductivity cell	3.6	3.6	$umhos \cdot cm^{-1}$	
Sulfate ($SO_4^=$)	Barium chloranilate, UV spectrophotometric	1.0	1.0	$mg \cdot L^{-1}$	
Nitrate (NO_3^-)	Automated colorimetric cadmium-copper reduction	0.01	0.01	$mg \cdot L^{-1}$	N
Ammonia (NH_3)	Automated colorimetric phenol hypochlorite	0.005	0.005	$mg \cdot L^{-1}$	N
Chloride (Cl^-)	Automated colorimetric thiocyanate combined reagent	0.5	0.5	$mg \cdot L^{-1}$	
METALS:	Inductively coupled argon plasma				
Al	Inductively coupled argon plasma	0.05	0.05	$mg \cdot L^{-1}$	
As	Inductively coupled argon plasma	0.075	0.05	$mg \cdot L^{-1}$	
Ba	Inductively coupled argon plasma	0.001	0.001	$mg \cdot L^{-1}$	
Be	Inductively coupled argon plasma	0.001	0.001	$mg \cdot L^{-1}$	
Ca	Inductively coupled argon plasma	0.1	0.1	$mg \cdot L^{-1}$	
Cd	Inductively coupled argon plasma	0.004	0.002	$mg \cdot L^{-1}$	
Co	Inductively coupled argon plasma	0.0075	0.005	$mg \cdot L^{-1}$	
Cr	Inductively coupled argon plasma	0.0075	0.005	$mg \cdot L^{-1}$	
Cu	Inductively coupled argon plasma	0.005	0.005	$mg \cdot L^{-1}$	
Fe	Inductively coupled argon plasma	0.005	0.005	$mg \cdot L^{-1}$	
Hg	Inductively coupled argon plasma	0.05	0.05	$mg \cdot L^{-1}$	
Mg	Inductively coupled argon plasma	0.1	0.1		
Mn	Inductively coupled argon plasma	0.001	0.001	$mg \cdot L^{-1}$	
Mo	Inductively coupled argon plasma	0.015	0.005	$mg \cdot L^{-1}$	
Na	Inductively coupled argon plasma	0.5	0.2	$mg \cdot L^{-1}$	
Ni	Inductively coupled argon plasma	0.04	0.02[b]	$mg \cdot L^{-1}$	
Pb	Inductively coupled argon plasma	0.04	0.02	$mg \cdot L^{-1}$	
Sb	Inductively coupled argon plasma	0.04	0.05	$mg \cdot L^{-1}$	
Se	Inductively coupled argon plasma	0.075	0.05	$mg \cdot L^{-1}$	
Si	Inductively coupled argon plasma	0.1	0.1	$mg \cdot L^{-1}$	
Sn	Inductively coupled argon plasma	0.1	0.01	$mg \cdot L^{-1}$	
Sr	Inductively coupled argon plasma	0.001	0.001	$mg \cdot L^{-1}$	
Ti	Inductively coupled argon plasma	0.002	0.002	$mg \cdot L^{-1}$	
V	Inductively coupled argon plasma	0.02	0.01	$mg \cdot L^{-1}$	
Zn	Inductively coupled argon plasma	0.005	0.002	$mg \cdot L^{-1}$	

a - For June 1982 data, detection limits were 20% higher than those listed.
b - For March/April 1982 data the detection limit for Na was 0.05 $mg \cdot L^{-1}$.

Table 3a - Surface Water Chemistry

Watercourse	Time[b] (days)	pH	Alkalinity ($ueq \cdot L^{-1}$)[a]	Conductivity ($umhos \cdot cm^{-1}$)	Buffer Capacity ($ueq \cdot L^{-1} \cdot pH^{-1}$)
Adams Lake					
Apr 15/81	14	7.32	465.0	-	
Jun 03/81	17	7.00	303.8	-	
Sep 30/81	6	7.42	346.0	-	
Jun 09/82	1	7.11	413.6	53.1	
Jun 09/82	5	6.98	401.8	54.0	
Mar 16/83	1	7.31	454.0	58.7	
Adams River, (below lake)					
Jun 03/81	20	7.40	524.2	-	
Oct 01/81	5	7.82	946.0	-	
Mar 05/82	4	7.33	515.4	66.5	
Apr 01/82	5	7.40	527.2	70.3	
Jun 10/82	1	7.30	518.4	64.6	
Mar 15/83	3	7.55	618.0	77.7	
Adams River, (above lake)					
Jun 03/81	17	6.90	176.4	-	-89.4
Sep 30/81	6	7.02	304.0	-	
Mar 31/82	2	7.42	882.0	105.6	
Mar 31/82	6	7.40	883.8	104.6	
Jun 09/82	1	7.08	456.6	56.4	
Jun 09/82	5	6.98	441.0	57.5	
Mar 16/83	5	7.06	354.0	40.6	
Blue River					
Jun 03/81	20	6.81	151.8	-	-89.8
Sep 30/81	6	7.23	264.0	-	
Mar 31/82	2	7.23	387.2	55.1	
Mar 31/82	5	7.22	386.2	55.1	
Jun 08/82	3	6.79	180.4	24.2	
Jun 08/82	7	6.65	177.4	24.3	-137
Mar 15/83	3	7.30	324.0	38.8	
Bonaparte River					
Jun 01/81	18	8.00	2218.8	-	

a - 1 $ueq \cdot L^{-1} = 0.05\ mg \cdot L^{-1}$
b - pre-analytical storage time at 4°C

Table 3a (Cont'd) - Surface Water Chemistry

Watercourse	Time[b] (days)	pH	Alkalinity ($ueq \cdot L^{-1}$)[a]	Conductivity ($umhos \cdot cm^{-1}$)	Buffer Capacity ($ueq \cdot L^{-1} \cdot pH^{-1}$)
Boss Creek					
Jun 02/81	20	6.59	166.6	-	
Sep 30/81	6	7.29	362.0	-	
Mar 03/82	1	7.33	715.4	128.0	
Mar 03/82	6	7.30	711.4	128.0	
Mar 30/82	1	7.38	709.6	115.9	
Mar 30/82	6	7.37	703.6	115.7	
Jun 11/82	3	6.36	131.4	20.9	-150
Mar 16/83	5	7.09	534.0	74.0	
Bridge River					
Jun 01/81	18	7.89	1388.0	-	
Sep 29/81	6	8.10	2004.0	-	
Burton Creek					
Apr 18/81	10	7.69	1350.0	-	
Clearwater River					
Jun 03/81	20	7.39	573.2	-	
Oct 01/81	5	7.68	666.0	-	
Mar 04/82	4	7.54	754.6	88.5	
Mar 04/82	6	7.51	743.8	88.2	
Mar 31/82	2	7.59	805.6	94.1	
Mar 31/82	5	7.59	803.6	94.9	
Jun 08/82	2	7.40	631.2	72.9	
Jun 08/82	5	7.30	597.8	72.4	
Jun 09/82	1	7.28	613.4	70.3	
Mar 14/83	3	7.79	778.0	86.5	
Coldwater River					
Jun 05/81	18	7.45	656.6	-	
Oct 02/81	5	8.00	1568.0	-	

a - 1 $ueq \cdot L^{-1}$ = 0.05 $mg \cdot L^{-1}$
b - pre-analytical storage time at 4°C

Table 3a (Cont'd) - Surface Water Chemistry

Watercourse	Time[b] (days)	pH	Alkalinity ($ueq \cdot L^{-1}$)[a]	Conductivity ($umhos \cdot cm^{-1}$)	Buffer Capacity ($ueq \cdot L^{-1} \cdot pH^{-1}$)
Crazy Creek					
Jun 04/81	19	6.83	196.0	-	-113
Oct 02/81	5	7.11	210.0	-	
Mar 05/82	4	7.21	450.0	60.0	
Apr 01/82	5	7.33	426.4	57.6	
Jun 10/82	1	6.75	201.8	28.3	
Jun 10/82	4	6.60	200.0	26.1	-166
Mar 16/83	5	7.43	338.0	39.1	
Crooked Lake					
Jun 02/81	20	6.89	269.4	-	
Sep 30/81	6	7.27	274.0	-	
Jun 11/82	4	6.82	266.6	33.1	
Mar 16/83	5	6.85	132.0	16.5	-73.2
Deadman River					
Jun 01/81	18	7.61	1248.6	-	
Eagle River					
Jun 03/81	20	6.91	254.8	-	
Oct 02/81	5	7.14	264.0	-	
Mar 05/82	4	7.25	486.0	79.0	
Apr 01/82	5	7.21	468.4	78.1	
Apr 14/82	2	7.23	429.2	72.8	
Apr 19/82	1	7.30	449.8	75.1	
Apr 27/82	1	7.26	433.2	65.6	
May 04/82	6	7.10	383.2	64.8	
May 11/82	1	6.91	374.4	62.3	
May 17/82	2	7.00	290.0	43.3	
May 31/82	4	7.10	290.0	41.3	
Jun 10/82	1	6.71	266.0	37.6	
Jun 10/82	4	6.70	266.0	38.2	
Jun 16/82	1	6.86	231.2	33.1	
Jun 28/82	2	6.80	238.2	33.4	
Jul 05/82	4	6.95	254.8	36.0	
Jul 15/82	1	6.95	279.4	38.5	
Jul 19/82	2	7.00	284.2	39.2	
Mar 16/83	1	7.30	394.0	62.4	

a - 1 $ueq \cdot L^{-1}$ = 0.05 $mg \cdot L^{-1}$
b - pre-analytical storage time at 4°C

Table 3a (Cont'd) - Surface Water Chemistry

Watercourse	Time[b] (days)	pH	Alkalinity ($ueq \cdot L^{-1}$)[a]	Conductivity ($umhos \cdot cm^{-1}$)	Buffer Capacity ($ueq \cdot L^{-1} \cdot pH^{-1}$)
Finn Creek					
Jun 03/81	20	6.67	117.6	-	-87.9
Sep 30/81	6	7.17	246.0	-	
Mar 04/82	4	7.21	362.6	44.0	
Mar 04/82	6	7.18	360.6	44.0	
Mar 31/82	2	7.11	368.4	53.8	
Mar 31/82	6	7.11	370.4	53.1	
Jun 09/82	2	6.68	140.2	18.3	
Jun 08/82	7	6.49	133.2	18.0	
Mar 15/83	3	7.12	284.0	33.4	
Gollen Creek					
Apr 18/81	10	8.00	1800.0	-	
Hendrix Lake					
Jun 02/81	21	6.93	279.2	-	
Sep 30/81	6	7.19	456.0	-	
Mar 03/81	1	6.62	505.6	62.0	
Mar 03/81	6	6.63	499.8	62.0	
Mar 30/82	1	6.95	611.4	74.4	
Mar 30/82	6	6.92	619.4	75.3	
Jun 11/82	3	6.50	256.8	32.8	
Mar 16/83	1	6.61	408.0	52.6	
Hen Ingram Creek					
May 12/81	5	7.31	740.0	-	
Horsefly River					
May 12/81	7	7.69	760.0	-	
Jun 02/81	21	7.00	303.8	-	
Sep 30/81	5	7.50	470.0	-	
Mar 02/82	2	7.36	660.6	87.5	
Mar 02/82	7	7.30	668.4	87.2	
Mar 30/82	1	7.43	684.0	91.5	
Mar 30/82	6	7.43	695.8	90.3	
Jun 11/82	3	6.69	244.0	33.5	
Mar 16/83	5	7.60	664.0	82.0	

a - 1 $ueq \cdot L^{-1}$ = 0.05 $mg \cdot L^{-1}$
b - pre-analytical storage time at 4°C

Table 3a (Cont'd) - Surface Water Chemistry

Watercourse	Time[b] (days)	pH	Alkalinity ($ueq \cdot L^{-1}$)[a]	Conductivity ($umhos \cdot cm^{-1}$)	Buffer Capacity ($ueq \cdot L^{-1} \cdot pH^{-1}$)
Little Horsefly River					
May 12/81	5	7.60	1126.0	-	
Loon Creek					
Jun 01/81	18	8.18	3661.6	-	
Louis Creek					
Jun 02/81	21	7.75	1519.0	-	
Lower Shuswap River					
Jun 04/81	19	7.37	739.8	-	
Oct 01/81	5	7.80	824.0	-	
McKinley Lake					
Jun 02/81	21	7.44	862.4	-	
Sep 30/81	6	7.65	870.0	-	
Mitchell River					
Jun 12/82	2	6.99	618.0	72.4	
Mcmich River					
Apr 15/81	14	7.28	350.0	-	
Nicola River					
Jun 05/81	18	7.78	1964.8	-	
North Barriere River					
Apr 20/81	8	7.03	550.0	-	
Jun 02/81	20	7.06	323.2	-	
Oct 01/81	5	7.42	422.0	-	
Mar 04/82	4	7.61	1093.6	126.0	
	6	7.75	1107.4	125.4	

a - 1 $ueq \cdot L^{-1} = 0.05\ mg \cdot L^{-1}$
b - pre-analytical storage time at 4°C

Table 3a (Cont'd) - Surface Water Chemistry

Watercourse	Time[b] (days)	pH	Alkalinity ($ueq \cdot L^{-1}$)[a]	Conductivity ($umhos \cdot cm^{-1}$)	Buffer Capacity ($ueq \cdot L^{-1} \cdot pH^{-1}$)
North Barriere River (Cont'd)					
Mar 31/82	2	7.92	1229.0	143.2	
Mar 31/82	5	7.85	1234.8	144.5	
Jun 08/82	2	7.35	556.6	-	
Jun 08/82	6	7.20	537.0	65.6	
Mar 14/83	4	7.99	1118.0	125.2	
Quesnel Lake					
Jun 14/78	20	8.10	950.0	-	
May 13/81	6	7.52	986.0	-	
May 15/81	4	7.66	930.0	-	
Raft River					
Jun 02/81	17	6.70	174.0	-	-124
Oct 01/81	5	7.43	432.0	-	
Mar 04/82	4	7.48	670.4	87.5	
Mar 04/82	6	7.50	670.4	87.2	
Mar 31/82	2	7.51	683.0	90.7	
Mar 31/82	6	7.53	684.0	89.5	
Apr 05/82	1	7.52	686.0	92.3	
Apr 13/82	1	7.51	650.8	86.8	
Apr 19/82	1	7.50	668.4	89.2	
Apr 27/82	1	7.27	478.2	66.0	
May 03/82	7	7.17	424.6	60.1	
May 10/82	1	7.20	384.2	54.4	
May 17/82	2	6.83	237.2	32.3	
May 27/82	1	6.91	208.8	28.2	
Jun 01/82	3	6.69	149.0	22.9	-108
Jun 09/82	1	6.80	174.0	22.7	-105
Jun 09/82	6	6.80	180.4	22.6	
Jun 15/82	1	6.60	125.4	17.3	-104
Jun 21/82	1	6.75	146.0	19.1	
Jun 28/82	4	6.77	187.2	24.2	
Jul 05/82	1	6.82	184.2	24.0	
Jul 12/82	2	7.23	299.0	36.0	
Jul 19/82	2	7.19	254.8	31.4	
Mar 14/83	4	7.50	508.0	62.4	

a - 1 $ueq \cdot L^{-1}$ = 0.05 $mg \cdot L^{-1}$

b - pre-analytical storage time at 4°C

Table 3a (Cont'd) - Surface Water Chemistry

Watercourse	Time[b] (days)	pH	Alkalinity ($ueq \cdot L^{-1}$)[a]	Conductivity ($umhos \cdot cm^{-1}$)	Buffer Capacity ($ueq \cdot L^{-1} \cdot pH^{-1}$)
Seton River					
Jun 01/81	18	7.59	611.8	-	
Sep 29/81	6	7.70	680.0	-	
Seymour River					
Jun 03/81	20	6.74	142.0	-	-94.9
Oct 01/82	5	7.14	226.0	-	
Jun 10/82	1	6.69	156.8	20.4	
Jun 10/82	5	6.60	152.8	20.9	-127
Mar 16/83	5	7.12	290.0	34.7	

a - 1 $ueq \cdot L^{-1}$ = 0.05 $mg \cdot L^{-1}$
b - pre-analytical storage time at 4°C

Table 3b - Surface Water Chemistry

Watercourse	Hardness ($mg \cdot L^{-1}$)	Sulfate ($mg \cdot L^{-1}$)	Nitrate-N ($mg \cdot L^{-1}$)	Ammonia-N ($mg \cdot L^{-1}$)	Chloride ($mg \cdot L^{-1}$)
Adams Lake					
Jun 03/81	16.9	-	-	-	-
Sep 30/81	17.7	-	-	-	-
Jun 09/82	24.4	4.9	0.08	ND	1.0
Mar 16/83	24.3	-	-	-	-
Adams River, (below lake)					
Jun 03/81	29.3	-	-	-	-
Oct 01/81	48.4	-	-	-	-
Mar 05/82	28.5	7.2	0.12	ND	0.96
Apr 01/82	28.3	5.5	0.10	ND	ND
Jun 10/82	31.8	5.7	0.09	ND	0.7
Mar 15/83	34.5	-	-	-	-
Adams River, (above lake)					
Jun 03/81	11.5	-	-	-	-
Sep 30/81	15.8	-	-	-	-
Mar 31/82	45.5	7.2	0.10	0.006	ND
Jun 09/82	28.3	5.0	0.12	ND	0.5
Mar 16/83	19.1	-	-	-	-
Blue River					
Jun 03/81	9.23	-	-	-	-
Sep 30/81	14.1	-	-	-	-
Mar 31/82	20.7	5.5	0.15	ND	0.6
Jun 08/82	12.0	3.6	0.15	ND	0.8
Mar 15/83	18.6	-	-	-	-
Bonaparte River					
Jun 01/81	96.3	-	-	-	-
Boss Creek					
Jun 02/81	12.6	-	-	-	-
Sep 30/81	18.3	-	-	-	-
Mar 03/82	47.5	23.3	0.43	0.011	1.68
Mar 30/82	43.4	16.1	0.34	ND	1.1
Jun 11/82	11.7	4.6	0.01	0.006	1.4
Mar 16/82	32.6	-	-	-	-

ND - Not Detected
(-) No Measurements

Table 3b (Cont'd) - Surface Water Chemistry

Watercourse	Hardness ($mg \cdot L^{-1}$)	Sulfate ($mg \cdot L^{-1}$)	Nitrate-N ($mg \cdot L^{-1}$)	Ammonia-N ($mg \cdot L^{-1}$)	Chloride ($mg \cdot L^{-1}$)
Bridge River					
Jun 01/81	86.9	-	-	-	-
Burton Creek	No Measurements				
Clearwater River					
Jun 03/81	31.5	-	-	-	-
Oct 01/81	34.0	-	-	-	-
Mar 04/82	38.9	7.3	0.09	ND	0.85
Mar 31/82	39.8	5.6	0.07	ND	ND
Jun 08/82	-	-	-	-	-
Jun 09/82	35.7	5.4	0.09	ND	0.5
Mar 14/83	41.6	-	-	-	-
Coldwater River					
Jun 05/81	33.4	-	-	-	-
Oct 02/81	73.5	-	-	-	-
Crazy Creek					
Jun 04/81	11.7	-	-	-	-
Oct 02/81	12.7	-	-	-	-
Mar 05/82	24.7	7.7	0.13	ND	0.72
Apr 01/82	23.3	5.3	0.11	ND	0.5
Jun 10/82	13.2	3.4	0.18	ND	0.8
Mar 16/83	18.9	-	-	-	-
Crooked Lake					
Jun 02/81	15.9	-	-	-	-
Sep 30/81	14.5	-	-	-	-
Jun 11/82	16.8	4.4	0.02	ND	1.0
Mar 16/83	13.2	-	-	-	-
Deadman River					
Jun 01/81	61.3	-	-	-	-

ND - Not Detected
(-) No Measurements

Table 3b (Cont'd) - Surface Water Chemistry

Watercourse	Hardness ($mg \cdot L^{-1}$)	Sulfate ($mg \cdot L^{-1}$)	Nitrate-N ($mg \cdot L^{-1}$)	Ammonia-N ($mg \cdot L^{-1}$)	Chloride ($mg \cdot L^{-1}$)
Eagle River					
Jun 03/81	16.0	-	-	-	-
Oct 02/81	15.9	-	-	-	-
Mar 05/82	31.0	11.2	0.11	ND	1.93
Apr 01/82	30.3	9.4	0.11	ND	1.9
Jun 10/82	17.4	5.0	0.15	ND	0.8
Mar 16/83	25.9	-	-	-	-
Finn Creek					
Jun 03/81	6.82	-	-	-	-
Sep 30/81	12.0	-	-	-	-
Mar 04/82	18.5	4.3	0.11	ND	1.34
Mar 31/82	19.2	3.2	0.11	ND	2.5
Jun 08/82	8.71	3.2	0.06	ND	0.6
Mar 15/83	14.3	-	-	-	-
Gollen Creek					
Apr 18/81	-	-	-	-	-
Hendrix Lake					
Jun 02/81	17.5	-	-	-	-
Sep 30/81	22.8	-	-	-	-
Mar 03/82	28.0	6.1	0.10	0.020	1.38
Mar 30/82	33.4	4.3	0.12	0.008	1.0
Jun 11/82	18.7	4.5	0.07	0.007	1.3
Mar 16/83	23.9	-	-	-	-
Hen Ingram Creek	No Measurements				
Horsefly River					
Jun 02/81	18.0	-	-	-	-
Sep 30/81	26.1	-	-	-	-
Mar 02/82	39.2	8.9	0.17	ND	0.68
Mar 30/82	39.1	7.7	0.18	ND	ND
Jun 11/82	18.2	4.8	0.11	ND	0.9
Mar 16/83	38.4	-	-	-	-
Little Horsefly River	No Measurements				

ND - Not Detected
(-) No Measurements

Table 3b (Cont'd) - Surface Water Chemistry

Watercourse	Hardness ($mg \cdot L^{-1}$)	Sulfate ($mg \cdot L^{-1}$)	Nitrate-N ($mg \cdot L^{-1}$)	Ammonia-N ($mg \cdot L^{-1}$)	Chloride ($mg \cdot L^{-1}$)
Loon Creek					
Jun 01/81	137.0	-	-	-	-
Louis Creek					
Jun 02/81	90.2	-	-	-	-
Lower Shuswap River					
Jun 04/81	40.3	-	-	-	-
Oct 01/81	41.5	-	-	-	-
McKinley Lake					
Jun 02/81	44.7	-	-	-	-
Sep 30/81	43.7	-	-	-	-
Mitchell River			No Measurements		
Momich River			No Measurements		
Nicola River					
Jun 05/81	103.0	-	-	-	-
North Barriere River					
Jun 02/81	16.5	-	-	-	-
Oct 01/81	19.8	-	-	-	-
Mar 04/82	57.4	8.4	0.08	ND	0.94
Mar 31/82	63.6	9.2	0.08	0.006	0.7
Jun 08/82	32.1	4.8	0.04	ND	ND
Mar 14/83	63.5	-	-	-	-
Quesnel Lake			No Measurements		
Raft River					
Jun 02/81	10.6	-	-	-	-
Oct 01/81	20.9	-	-	-	-
Mar 04/82	35.5	9.8	0.11	ND	1.15
Mar 31/82	36.0	8.2	0.10	ND	0.6
Jun 09/82	12.0	4.4	0.02	0.005	0.6
Mar 14/83	27.5	-	-	-	-

ND - Not Detected
(-) No Measurements

Table 3b (Cont'd) - Surface Water Chemistry

Watercourse	Hardness ($mg \cdot L^{-1}$)	Sulfate ($mg \cdot L^{-1}$)	Nitrate-N ($mg \cdot L^{-1}$)	Ammonia-N ($mg \cdot L^{-1}$)	Chloride ($mg \cdot L^{-1}$)
Seton River					
Jun 01/81	37.3	-	-	-	-
Sep 29/81	36.5	-	-	-	-
Seymour River					
Jun 03/81	9.02	-	-	-	-
Oct 01/82	12.4	-	-	-	-
Jun 10/82	9.91	3.3	0.10	ND	ND
Mar 16/83	16.4	-	-	-	-

ND - Not Detected

(-) No Measurements

Table 4a - Snowmelt Chemistry, 1982

Area	Date Sampled	Time[c] (days)	pH	Conductivity (umhos·cm^{-1})	Ratio of Snow Volume/ Melt Volume	Depth of Snowcore (cm)
Adams River, (below lake)	1.[a] Mar 05/82	11	5.09	<3.6	6.1	59 & 57[b]
	2. Mar 05/82	11	5.20	<3.6	5.6	65 & 60
	3. Mar 05/82	11	5.46	<3.6	8.0	57 & 55
Adams River, (above lake)	1. Mar 31/82	7	5.31	<3.6	5.2	70
	2. Mar 31/82	7	5.31	<3.6	5.4	70
Eagle River	1. Mar 05/82	10	5.26	<3.6	5.5	65 & 65
	2. Mar 05/82	10	5.26	<3.6	4.9	67 & 68
	3. Mar 05/82	10	5.40	<3.6	4.9	65 & 57
Finn Creek	1. Mar 04/82	8	4.90	4.7	7.5	134
	2. Mar 04/82	8	4.91	5.2	6.6	131
	3. Mar 04/82	11	5.03	4.3	8.7	130
Horsefly River	1. Mar 02/82	9	4.91	<3.6	8.0	98
	2. Mar 02/82	9	4.99	<3.6	7.3	100
	3. Mar 02/82	9	4.99	4.0	7.5	93
Raft River	1. Mar 04/82	7	5.27	4.2	5.5	55 & 55
	2. Mar 04/82	8	5.27	4.7	5.6	50 & 62
	3. Mar 04/82	8	5.32	4.4	6.2	40 & 40

a - replicate samples
b - snowcore depths of combined samples
c - pre-analytical storage time at 4°C
ND - Not Detected

Table 4b - Snowmelt Chemistry, 1982

Sample Site	Date Collected	Sulfate ($mg \cdot L^{-1}$)	Nitrate ($mg \cdot L^{-1}$)	Ammonium ($mg \cdot L^{-1}$)	Chloride ($mg \cdot L^{-1}$)
Adams River, (below lake)	1.[a]Mar 05/82	1.4	0.93	0.036	ND
	2. Mar 05/82	1.4	0.62	0.039	0.5
	3. Mar 05/82	1.5	0.66	0.034	0.5
Adams River, (above lake)	No Measurements				
Eagle River	1. Mar 05/82	1.5	0.40	0.009	ND
	2. Mar 05/82	1.5	0.58	0.013	ND
	3. Mar 05/82	1.6	0.22	ND	ND
Finn Creek	1. Mar 04/82	1.9	0.49	0.015	0.7
	2. Mar 04/82	1.5	0.40	0.031	0.7
	3. Mar 04/82	2.2	0.44	0.025	0.6
Horsefly River	1. Mar 02/82	1.5	0.27	0.015	ND
	2. Mar 02/82	1.4	0.22	0.009	0.5
	3. Mar 02/82	1.8	0.27	0.014	0.5
Raft River	1. Mar 04/82	1.5	0.40	0.013	0.8
	2. Mar 04/82	1.3	0.44	0.039	0.8
	3. Mar 04/82	1.4	0.49	0.036	0.8

a - replicate samples
ND - Not Detected

Table 5 - Snowmelt Chemistry, 1983

Area		Date Sampled	Time[c] (days)	pH	Conductivity ($\mu mhos \cdot cm^{-1}$)	Ration of Snow Volume/ Melt Volume	Depth of Snowcore (cm)
Adams River, (above lake)	1.[a]	Mar 16/83					25
	2.	Mar 16/83	9	5.26	<3.6	1.9	25
Blue River	1.	Mar 15/83	13	5.84	<3.6	5.0	58 & 54[b]
	2.	Mar 15/83	13	5.98	<3.6	5.4	57 & 55
Boss Creek	1.	Mar 16/83	8	5.75	<3.6	5.4	49 & 50
	2.	Mar 16/83	8	5.68	<3.6	5.2	48 & 55
Horsefly River	1.	Mar 16/83					41 & 41
	2.	Mar 16/83	9	5.60	<3.6	5.3	45 & 47
Seymour River	1.	Mar 16/83	8	4.99	<3.6	4.7	61 & 65
	2.	Mar 16/83	2	5.43	<3.6	4.7	65 & 64

a - replicate samples
b - snowcore depths of combined samples
c - pre-analytical storage time at 4°C

ND - Not Detected

APPENDIX I
SITE DESCRIPTIONS
(Distances are given by land routes)

Adams Lake - 40 km southeast of Vavenby on the Momich Lake road, on the east shore of the northern end of Adams Lake.

Adams River (above Adams Lake) - 35 km southeast of Vavenby on the Adams Lake logging road, immediately upstream of the (southernmost) Adams River bridge.

Adams River (below lake) - 3.5 km north of the Trans Canada Highway on the Shuswap Lake Road, immediately upstream of the Adams River bridge.

Blue River - 2 km north of the town of Blue River, immediately upstream of the Blue River bridge.

Bonaparte River - 13 km northeast of Highway 97 on the Loon Lake Provincial Park access road, immediately upstream of the Bonaparte River/Loon Creek confluence.

Boss Creek - 60 km northeast of 100 Mile House on the Hendrix Lake Road, immediately upstream of the Boss Creek bridge.

Bridge River - 8 km north of Lillooet, immediately upstream of the Bridge River bridge.

Burton Creek - On the Adams Lake (west side) logging road at kilometer 75, immediately upstream of the road crossing.

Clearwater River - 2 km northwest of Clearwater on the Old North Thompson Highway, immediately upstream of the Clearwater River bridge.

Coldwater River - at Merritt, immediately upstream of the sewage treatment plant outfall.

Crazy Creek - immediately upstream of the Crazy Creek Canadian Pacific Railway bridge, adjacent to the Trans Canada Highway.

Crooked Lake - 110 km northeast of 150 Mile House on the Crooked Lake Resort access road, on the northeast shore of Crooked Lake at the camping area.

Deadman River - 6 km west of Savona on the Trans Canada Highway, immediately upstream of the Deadman River bridge.

Eagle River - immediately upstream of the Eagle River Canadian Pacific Railway bridge, adjacent to the Trans Canada Highway.

Finn Creek - 80 km northeast of Clearwater on the Yellowhead Highway, immediately upstream of the Finn Creek bridge.

Gollen Creek - on the Adams Lake (west side) logging road at kilometer 80, immediately upstream of the road crossing.

Hen Ingram Creek - on the secondary road which leads to Hen Ingram Lake at kilometer 10.

Hendrix Lake - 77 km northeast of 100 Mile House on Hendrix Lake road, south of the townsite on the southeast shore of the lake.

Horsefly River - 95 km northeast of 150 Mile House on Black Creek road, immediately upstream of the Horsefly River bridge.

Little Horsefly River - immediately upstream of the bridge which crosses the Little Horsefly River on the Quesnel Lake road.

Loon Creek - 13 km northeast of Highway 97 on the Loon Lake Provincial Park access road, immediately upstream of the Loon Creek/Bonaparte River confluence.

Louis Creek - near the community of Louis Creek on the Trans Canada Highway, immediately upstream of the Louis Creek bridge.

Lower Shuswap River - 12 km southeast of Enderby on the Trinity Valley road, immediately upstream of the Lower Shuswap River bridge.

McKinley Lake - 85 km northeast of 150 Mile House on the McKinley Lake access road, on the north shore of the northwest arm of the lake.

Mitchell River - at the head of the north arm of Quesnel Lake, approximately 100 meters upstream from the Lake.

Momich River - at kilometer 14.5 on the (east side) logging road of Adams Lake at the junction of the Momich-Seymour Arms logging road, immediately upstream of junction.

Nicola River - on Highway 5 at the town of Merritt, immediately upstream of the Nicola River bridge.

North Barriere River - 4.5 km northeast of Barriere, on the North Barriere River road, immediately upstream of the North Barriere River bridge.

Quesnel Lake - in the vicinity of the junction of the north, west and east arms of the Lake.

Raft River - 6 km east of Clearwater on the Yellowhead Highway, immediately upstream of the Raft River bridge.

Seton River - 2 km south of Lillooet, immediately upstream of the Seton River bridge.

Seymour River - 85 km north of the Trans Canada Highway on the Shuswap Lake Road, immediately upstream of the Seymour River bridge.

APPENDIX 2

SURFACE WATER CHEMISTRY - METALS

ADAMS LAKE

Metal	Sample Dates								
	Jun 03/81		Sep 30/81		Jun 09/82		Mar 16/83		
($mg.L^{-1}$)	Ext	Tot	Ext	Tot	Ext	Tot	Ext	Tot	Diss
Al	0.25	0.19	ND	0.06	0.06	0.09	ND	0.06	ND
As	ND	—	ND	—	ND	ND	ND	ND	ND
Ba	0.008	0.006	0.005	0.006	0.007	0.018	0.007	0.007	0.007
Be	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ca	5.5	5.8	5.8	6.5	7.8	7.6	7.8	7.7	7.8
Cd	ND	ND	ND	ND	ND	ND	ND	ND	ND
Co	ND	—	ND	—	ND	ND	ND	ND	ND
Cr	ND	ND	ND	ND	—	ND	ND	ND	ND
Cu	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fe	0.307	0.347	0.059	0.169	0.065	0.084	0.048	0.043	0.027
Hg	ND	—	ND	—	ND	ND	ND	ND	ND
Mg	0.8	0.9	0.8	0.9	1.2	1.2	1.2	1.2	1.2
Mn	0.007	0.004	0.006	0.003	0.002	0.003	0.002	ND	0.001
Mo	ND	ND	ND	ND	ND	ND	ND	ND	ND
Na	0.8	1.0	0.8	0.9	1.0	1.3	1.1	1.1	1.2
Ni	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pb	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sb	—	ND	—	ND	ND	ND	ND	ND	ND
Se	ND	—	ND	—	ND	ND	ND	ND	ND
Si	3.1	3.2	2.9	2.9	3.4	3.2	3.3	3.2	3.3
Sn	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sr	0.037	0.038	0.038	0.041	0.050	0.051	0.052	0.050	0.051
Ti	0.033	0.016	0.012	0.011	0.002	0.005	0.004	0.003	0.002
V	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zn	ND	ND	ND	ND	ND	ND	ND	ND	ND

Ext = Extractable
Tot = Total
Diss = Dissolved
ND = Not Detected

SURFACE WATER CHEMISTRY - METALS

ADAMS RIVER, (below lake)

Metal	Sample Dates												
	Jun 03/81		Oct 01/81		Mar 05/83		Apr 01/82		Jun 10/82		Mar 15/83		
($mg.L^{-1}$)	Ext	Tot	Ext	Tot	Ext	Tot	Ext	Tot	Ext	Tot	Ext	Tot	Diss
Al	0.31	0.68	0.07	0.19	ND	ND	0.06	ND	0.08	0.13	ND	ND	ND
As	ND	--	ND	--	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ba	0.016	0.017	0.020	0.021	0.007	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008
Be	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ca	9.3	9.3	15.4	17.7	9.1	9.0	9.0	9.6	9.8	9.7	11.1	10.7	10.9
Cd	ND	ND	ND	ND	ND	ND	0.003	ND	ND	ND	ND	ND	ND
Co	ND	--	ND	--	ND	ND	0.006	ND	ND	ND	ND	ND	ND
Cr	ND	ND	ND	ND	ND	0.016	0.005	ND	--	ND	ND	ND	ND
Cu	ND	ND	ND	ND	ND	0.01	0.006	ND	ND	ND	ND	ND	ND
Fe	0.353	0.865	0.122	0.447	0.018	0.131	0.047	0.059	0.112	0.129	0.024	0.036	ND
Hg	ND	--	ND	--	ND	ND	ND	ND	ND	ND	ND	ND	ND
Mg	1.5	1.6	2.4	2.8	1.4	1.7	1.4	1.5	1.5	1.5	1.7	1.6	1.6
Mn	0.018	0.024	0.007	0.010	0.002	0.003	0.003	0.002	0.005	0.004	0.003	0.003	0.001
Mo	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Na	0.7	0.8	1.2	1.5	1.1	1.2	1.2	1.1	1.0	1.2	1.2	1.1	1.2
Ni	ND	ND	ND	ND	ND	ND	ND	0.05	ND	ND	ND	ND	ND
Pb	ND	ND	ND	ND	ND	ND	0.03	ND	ND	ND	ND	ND	ND
Sb	ND	--	ND	--	ND	0.06	ND	ND	ND	ND	ND	ND	ND
Se	ND	--	ND	--	ND	0.09	ND	ND	ND	ND	ND	ND	ND
Si	3.5	4.2	3.6	4.4	2.9	2.8	2.7	2.6	3.2	3.1	3.0	2.8	2.9
Sn	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sr	0.069	0.068	0.127	0.144	0.057	0.058	0.055	0.064	0.059	0.059	0.069	0.066	0.068
Ti	0.025	0.045	0.011	0.017	ND	ND	0.004	0.002	0.003	0.003	0.002	0.002	0.003
V	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zn	ND	0.007	ND	0.011	0.003	0.004	ND	0.004	ND	ND	ND	ND	ND

Ext = Extractable
Tot = Total
Diss = Dissolved
ND = Not Detected

SURFACE WATER CHEMISTRY - METALS

ADAMS RIVER, (above lake)

Metal	Sample Dates										
	Jun 03/81		Sep 30/81		Mar 31/82		Jun 09/82		Mar 16/83		
($mg.L^{-1}$)	Ext	Tot	Ext	Tot	Ext	Tot	Ext	Tot	Ext	Tot	Diss
Al	0.43	0.57	0.06	0.14	ND	ND	0.17	0.24	0.1	0.15	ND
As	ND	--	ND	--	ND	ND	ND	ND	ND	ND	ND
Ba	0.007	0.007	0.005	0.006	0.008	0.009	0.006	0.007	0.006	0.006	0.006
Be	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ca	3.9	3.6	5.4	6.2	14.2	14.4	8.7	8.3	6.3	6.1	6.3
Cd	ND	ND	ND	--	ND	ND	ND	ND	ND	ND	ND
Co	ND	--	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cr	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cu	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fe	0.475	0.484	0.115	0.423	0.120	0.148	0.217	0.271	0.195	0.227	0.094
Hg	ND	--	ND	--	ND	ND	ND	ND	ND	ND	ND
Mg	0.5	0.4	0.6	0.7	2.5	2.5	1.6	1.5	0.8	0.8	0.8
Mn	0.010	0.123	0.004	0.005	0.006	0.007	0.009	0.008	0.008	0.007	0.006
Mo	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Na	0.6	0.5	0.8	1.0	2.0	1.9	0.9	1.0	1.4	1.4	1.5
Ni	ND	ND	ND	ND	ND	0.02	ND	ND	ND	ND	ND
Pb	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sb	ND	--	ND	--	ND	ND	ND	ND	ND	ND	ND
Se	ND	--	ND	--	ND	ND	ND	ND	ND	ND	ND
Si	2.5	2.7	2.4	2.9	4.1	3.9	3.3	3.1	4.4	4.2	4.3
Sn	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sr	0.026	0.026	0.034	0.038	0.084	0.091	0.050	0.049	0.047	0.044	0.047
Ti	0.046	0.043	0.012	0.014	0.002	0.004	0.009	0.008	0.008	0.008	0.004
V	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zn	ND	ND	ND	0.006	ND	0.003	ND	ND	ND	ND	ND

Ext = Extractable
Tot = Total
Diss = Dissolved
ND = Not Detected

SURFACE WATER CHEMISTRY - METALS

BLUE RIVER

Metal ($mg.L^{-1}$)	Sample Dates: Jun 03/81 Ext	Jun 03/81 Tot	Sep 30/81 Ext	Sep 30/81 Tot	Mar 31/82 Ext	Mar 31/82 Tot	Jun 08/82 Ext	Jun 08/82 Tot	Mar 15/83 Ext	Mar 15/83 Tot	Mar 15/83 Diss
Al	0.17	0.25	0.07	0.16	0.08	0.06	0.13	0.13	0.06	0.05	ND
As	ND	--	ND	--	ND	ND	ND	ND	ND	ND	ND
Ba	0.002	0.003	0.003	0.004	0.004	0.005	0.003	0.004	0.004	0.004	0.004
Be	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ca	3.3	3.4	5.0	5.8	7.0	7.5	4.2	4.1	6.3	6.1	6.1
Cd	ND	ND	ND	ND	0.003	ND	ND	ND	ND	ND	ND
Co	ND	--	ND	--	ND	ND	ND	ND	ND	ND	ND
Cr	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cu	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fe	0.106	0.319	0.0684	0.438	0.092	0.149	0.075	0.062	0.055	0.065	0.031
Hg	ND	--	ND	--	ND	ND	ND	ND	ND	ND	ND
Mg	0.3	0.4	0.4	0.7	0.8	0.8	0.4	0.3	0.7	0.6	0.6
Mn	0.002	0.004	0.002	0.003	0.030	0.004	0.002	0.002	0.002	0.002	0.001
Mo	ND	ND	ND	ND	0.02	ND	ND	ND	ND	ND	ND
Na	ND	0.5	0.7	1.0	1.4	1.3	0.5	0.7	1.2	1.1	1.2
Ni	ND	ND	ND	ND	ND	0.03	ND	ND	ND	ND	ND
Pb	ND	ND	ND	ND	ND	0.02	ND	ND	ND	ND	ND
Sb	ND	--	ND	--	ND	ND	ND	ND	ND	ND	ND
Se	ND	--	ND	--	ND	ND	ND	ND	ND	ND	ND
Si	1.7	2.0	2.3	2.9	3.4	3.3	2.4	2.2	3.5	3.3	3.4
Sn	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sr	0.017	0.018	0.025	0.028	0.037	0.043	0.023	0.022	0.037	0.036	0.036
Ti	0.018	0.017	0.0010	0.014	0.003	0.005	0.003	ND	0.003	0.003	0.004
V	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zn	ND	ND	ND	0.008	0.016	0.023	ND	ND	ND	ND	ND

Ext = Extractable
Tot = Total
Diss = Dissolved
ND = Not Detected

SURFACE WATER CHEMISTRY - METALS

BONAPARTE RIVER

Metal ($mg.L^{-1}$)	Sample Dates: Jun 01/81 Ext	Jun 01/81 Tot
Al	0.1	0.4
As	ND	--
Ba	0.033	0.032
Be	ND	ND
Ca	21.1	21.8
Cd	ND	ND
Co	ND	--
Cr	ND	ND
Cu	ND	ND
Fe	0.270	0.722
Hg	ND	--
Mg	10.6	10.9
Mn	0.021	0.025
Mo	ND	ND
Na	8.8	8.7
Ni	ND	ND
Pb	ND	ND
Sb	ND	--
Se	ND	--
Si	4.9	5.7
Sn	ND	ND
Sr	0.180	0.180
Ti	0.013	0.031
V	ND	ND
Zn	ND	ND

Ext = Extractable
Tot = Total
ND = Not Detected

SURFACE WATER CHEMISTRY - METALS

BOSS CREEK

Metal	Sample Dates												
	Jun 02/81		Sep 30/81		Mar 03/82		Mar 30/82		Jun 11/82		Mar 16/83		
($mg.L^{-1}$)	Ext	Tot	Ext	Tot	Ext	Tot	Ext	Tot	Ext	Tot	Ext	Tot	Diss
Al	0.39	0.83	0.09	0.17	0.08	ND	ND	0.07	0.48	0.68	0.12	0.15	0.10
As	ND	--	ND	--	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ba	0.009	0.002	0.007	0.007	0.015	0.015	0.013	0.014	0.009	0.012	0.009	0.01	0.009
Be	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ca	3.9	4.2	5.5	6.3	15.0	14.7	13.6	13.7	3.4	3.3	9.9	9.7	9.8
Cd	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Co	ND	--	ND	--	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cr	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cu	ND	0.005	ND	0.009	ND	0.007	ND	ND	ND	ND	ND	ND	ND
Fe	0.337	0.782	0.141	0.425	0.137	0.181	0.125	0.199	0.460	0.592	0.200	0.237	0.153
Hg	ND	--	ND	--	ND	ND	ND	ND	ND	ND	ND	ND	ND
Mg	0.7	0.9	1.1	1.3	2.4	2.7	2.3	2.4	0.8	0.7	1.9	1.8	1.9
Mn	0.013	0.019	--	0.007	0.011	0.012	0.009	0.010	0.018	0.020	0.011	0.011	0.009
Mo	0.074	0.074	0.051	0.045	0.388	0.367	0.281	0.286	0.027	ND	0.141	0.143	0.142
Na	1.2	1.3	1.6	1.8	5.5	5.4	5.1	5.0	1.0	1.1	2.6	2.5	2.6
Ni	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pb	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sb	ND	--	ND	--	ND	0.06	ND	ND	ND	ND	ND	ND	ND
Se	ND	--	ND	--	ND	0.08	ND	ND	ND	ND	ND	ND	ND
Si	3.0	4.1	3.5	4.2	5.0	4.7	4.9	4.6	3.3	3.6	4.9	4.8	4.9
Sn	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sr	0.018	0.019	0.024	0.028	0.058	0.057	0.054	0.057	0.017	0.016	0.040	0.039	0.040
Ti	0.016	0.039	0.009	0.011	ND	ND	ND	0.003	0.014	0.033	0.004	0.007	0.005
V	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zn	ND	ND	ND	0.012	ND	ND	ND	ND	0.005	ND	ND	ND	ND

Ext = Extractable
Tot = Total
Diss = Dissolved
ND = Not Detected

SURFACE WATER CHEMISTRY - METALS

BRIDGE RIVER

Metal ($mg.L^{-1}$)	Sample Dates Jun 01/81 Ext	Tot
Al	0.73	1.75
As	ND	--
Ba	0.013	0.015
Be	ND	ND
Ca	16.0	16.5
Cd	ND	ND
Co	ND	--
Cr	0.013	0.020
Cu	ND	ND
Fe	1.390	2.640
Hg	ND	--
Mg	11.4	12.1
Mn	0.040	0.056
Mo	ND	ND
Na	2.5	2.5
Ni	ND	ND
Pb	ND	ND
Sb	ND	--
Se	ND	--
Si	5.3	8.9
Sn	ND	ND
Sr	0.109	0.110
Ti	0.285	0.102
V	ND	ND
Zn	ND	0.006

Ext = Extractable
Tot = Total
ND = Not Detected

SURFACE WATER CHEMISTRY - METALS

CLEARWATER RIVER

Metal	Sample Dates												
	Jun 03/81		Oct 01/81		Mar 04/82		Mar 31/82		Jun 09/82		Mar 14/81		
($mg.L^{-1}$)	Ext	Tot	Ext	Tot	Ext	Tot	Ext	Tot	Ext	Tot	Ext	Tot	Diss
Al	0.18	0.35	ND	0.10	ND	ND	ND	ND	0.17	0.19	ND	ND	ND
As	ND	--	ND	--	ND	ND	ND	ND	ND	ND	ND	ND	ND
Be	0.005	0.006	0.004	0.004	0.005	0.005	0.006	0.006	0.006	0.006	0.006	0.006	0.005
Be	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ca	10.0	10.4	11.1	12.5	11.6	11.6	11.6	12.3	11.1	10.7	12.2	11.9	12.0
Cd	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Co	ND	--	ND	--	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cr	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cu	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fe	0.395	0.589	0.044	0.388	0.051	0.120	0.071	0.105	0.223	0.228	0.112	0.120	0.560
Hg	ND	--	ND	--	ND	ND	ND	ND	ND	ND	ND	ND	ND
Mg	1.6	1.7	1.5	1.8	2.4	2.7	2.6	2.8	2.0	1.9	2.7	2.6	2.6
Mn	0.009	0.010	0.001	0.003	0.002	0.002	0.002	0.003	0.005	0.005	0.004	0.003	0.001
Mo	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Na	1.1	1.2	0.8	1.1	1.6	1.7	1.8	2.1	1.3	1.4	1.8	1.7	1.9
Ni	ND	ND	ND	ND	ND	ND	ND	0.03	ND	ND	ND	ND	ND
Pb	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sb	ND	--	ND	--	ND	ND	ND	ND	ND	ND	ND	ND	ND
Se	ND	--	ND	--	ND	0.09	ND	ND	ND	ND	ND	ND	ND
Si	2.2	2.6	1.5	2.0	2.3	2.4	2.4	2.3	2.5	2.4	2.9	2.8	2.8
Sn	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sr	0.067	0.067	0.074	0.082	0.076	0.076	0.076	0.085	0.069	0.067	0.081	0.078	0.09
Ti	0.021	0.029	0.009	0.012	ND	ND	ND	ND	0.007	0.010	0.003	0.003	0.003
V	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zn	ND	ND	ND	ND	ND	ND	ND	0.011	ND	ND	ND	ND	ND

Ext = Extractable
Tot = Total
Diss = Dissolved
ND = Not Detected

SURFACE WATER CHEMISTRY - METALS

COLDWATER RIVER

Metal	Sample Dates			
	Jun 05/81		Oct 02/81	
($mg.L^{-1}$)	Ext	Tot	Ext	Tot
Al	0.71	1.88	ND	0.10
As	ND	--	ND	--
Ba	0.031	0.033	0.037	0.038
Be	ND	ND	ND	ND
Ca	10.1	10.4	2.0	2.2
Cd	ND	ND	ND	ND
Co	ND	--	ND	--
Cr	ND	ND	ND	ND
Cu	ND	ND	ND	ND
Fe	0.793	1.750	0.085	0.387
Hg	ND	--	ND	--
Mg	22.8	25.6	4.0	4.5
Mn	0.037	0.053	0.013	0.016
Mo	ND	ND	ND	ND
Na	1.7	1.7	3.4	3.8
Ni	ND	ND	ND	ND
Pb	ND	ND	ND	ND
Sb	ND	--	ND	--
Se	ND	--	ND	--
Si	3.8	6.2	3.4	4.2
Sn	ND	ND	ND	ND
Sr	0.065	0.068	0.124	0.138
Ti	0.027	0.089	0.008	0.013
V	ND	ND	ND	ND
Zn	ND	ND	ND	0.013

Ext = Extractable
Tot = Total
ND = Not Detected

SURFACE WATER CHEMISTRY - METALS

CRAZY CREEK

Metal	Sample Dates												
	Jun 04/81		Oct 02/81		Mar 05/82		Apr 01/82		Jun 10/82		Mar 16/83		
($mg.L^{-1}$)	Ext	Tot	Ext	Tot	Ext	Tot	Ext	Tot	Ext	Tot	Ext	Tot	Diss
Al	0.43	0.73	0.40	0.60	ND	ND	ND	ND	0.19	0.20	0.07	0.06	0.07
As	ND	--	ND	--	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ba	0.012	0.013	0.013	0.013	0.013	0.013	0.012	0.013	0.010	0.009	0.010	0.010	0.010
Be	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ca	3.5	3.8	3.8	4.2	7.4	7.5	7.1	7.3	4.0	3.9	5.9	5.7	5.9
Cd	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Co	ND	--	ND	--	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cr	ND	ND	ND	ND	ND	0.008	ND	ND	--	ND	ND	ND	ND
Cu	ND	ND	ND	0.008	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fe	0.369	0.979	0.379	0.855	0.011	0.069	0.014	0.019	0.137	0.125	0.038	0.035	0.022
Hg	ND	--	ND	--	ND	ND	ND	ND	ND	ND	ND	ND	ND
Mg	0.7	0.9	0.8	1.0	1.5	1.8	1.4	1.4	0.8	0.1	1.0	1.0	1.1
Mn	0.007	0.014	--	0.014	ND	ND	ND	ND	0.002	0.002	ND	ND	ND
Mo	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Na	ND	0.6	ND	0.5	1.1	1.2	1.1	1.1	0.5	0.6	0.9	0.9	1.0
Ni	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pb	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sb	ND	--	ND	--	ND	0.05	ND	ND	ND	ND	ND	ND	ND
Se	ND	--	ND	--	ND	0.09	ND	ND	ND	ND	ND	ND	ND
Si	2.3	3.0	2.2	2.8	3.5	3.4	3.5	3.3	2.4	2.2	3.5	3.3	3.5
Sn	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sr	0.016	0.018	0.018	0.019	0.036	0.037	0.035	0.038	0.018	0.018	0.028	0.027	0.028
Ti	0.043	0.056	0.043	0.041	ND	ND	ND	0.003	0.012	0.009	0.004	0.004	0.004
V	ND	ND	ND	ND	ND	0.02	ND	0.01	ND	ND	ND	ND	ND
Zn	ND	ND	ND	0.005	ND	0.003	ND	0.005	ND	ND	ND	ND	ND

Ext = Extractable
Tot = Total
Diss = Dissolved
ND = Not Detected

SURFACE WATER CHEMISTRY - METALS

CROOKED LAKE

Metal	Sample Dates								
	Jun 02/81		Sep 30/81		Jun 11/82		Mar 16/83		
($mg.L^{-1}$)	Ext	Tot	Ext	Tot	Ext	Tot	Ext	Tot	Diss
Al	0.13	ND	ND	ND	0.08	0.10	ND	ND	ND
As	ND	--	ND	--	ND	ND	ND	ND	ND
Ba	0.004	0.004	0.003	0.004	0.004	0.005	0.003	0.003	0.002
Be	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ca	5.1	5.0	4.7	5.2	5.4	5.3	4.3	4.2	2.7
Cd	ND	ND	ND	ND	ND	ND	ND	ND	ND
Co	ND	--	ND	--	ND	ND	ND	ND	ND
Cr	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cu	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fe	0.113	ND	0.017	0.148	0.078	0.090	0.010	0.011	ND
Hg	ND	--	ND	--	ND	ND	ND	ND	ND
Mg	0.8	0.7	0.7	0.8	0.8	0.7	0.6	0.5	0.3
Mn	0.006	0.005	0.002	0.002	0.003	0.003	ND	ND	ND
Mo	ND	ND	ND	ND	ND	ND	ND	ND	ND
Na	0.8	0.6	0.6	0.6	0.7	0.8	0.6	0.6	0.5
Ni	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pb	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sb	ND	--	ND	--	ND	ND	ND	ND	ND
Se	ND	--	ND	--	ND	ND	ND	ND	ND
Si	2.0	2.1	1.6	2.0	2.1	2.0	1.5	1.4	1.0
Sn	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sr	0.023	0.022	0.020	0.022	0.023	0.023	0.018	0.018	0.012
Ti	0.013	0.008	0.008	0.010	ND	ND	ND	ND	0.004
V	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zn	ND	ND	ND	ND	0.007	0.002	ND	ND	0.002

Ext = Extractable
Tot = Total
Diss = Dissolved
ND = Not Detected

SURFACE WATER CHEMISTRY - METALS

DEADMAN RIVER

Metal	Sample Dates	
	Jun 01/81	
($mg.L^{-1}$)	Ext	Tot
Al	0.57	1.38
As	ND	--
Ba	0.013	0.015
Be	ND	ND
Ca	13.2	13.2
Cd	ND	ND
Co	ND	--
Cr	ND	ND
Cu	ND	ND
Fe	1.090	1.820
Hg	ND	--
Mg	6.9	6.8
Mn	0.045	0.053
Mo	ND	ND
Na	5.4	5.2
Ni	ND	ND
Pb	ND	ND
Sb	ND	--
Se	ND	--
Si	7.6	9.6
Sn	ND	ND
Sr	0.064	0.066
Ti	0.023	0.106
V	ND	ND
Zn	ND	ND

Ext = Extractable
Tot = Total
ND = Not Detected

SURFACE WATER CHEMISTRY - METALS

EAGLE RIVER

Metal	Sample Dates												
	Jun 03/81		Oct 02/81		Mar 05/82		Apr 01/82		Jun 10/82		Mar 16/83		
($mg.L^{-1}$)	Ext	Tot	Ext	Tot	Ext	Tot	Ext	Tot	Ext	Tot	Ext	Tot	Diss
Al	0.39	0.44	0.25	0.39	ND	ND	ND	ND	0.11	0.17	0.06	0.06	ND
As	ND	—	ND	—	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ba	0.010	0.009	0.010	0.012	0.008	0.010	0.008	0.009	0.007	0.007	0.007	0.007	0.007
Be	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ca	5.0	5.3	5.0	5.6	10.0	9.8	9.8	10.2	5.7	5.7	8.4	8.1	8.3
Cd	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Co	ND	—	ND	—	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cr	ND	ND	ND	ND	ND	0.007	ND	ND	ND	ND	ND	ND	ND
Cu	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fe	0.410	0.546	0.283	0.543	0.097	0.165	0.132	0.152	0.107	0.141	0.089	0.100	0.034
Hg	ND	—	ND	—	ND	ND	ND	ND	ND	ND	ND	ND	ND
Mg	0.9	0.9	0.9	1.0	1.5	1.8	1.4	1.5	0.8	0.9	1.2	1.1	1.1
Mn	0.007	0.008	0.009	0.012	0.004	0.004	0.005	0.006	0.003	0.003	0.003	0.003	0.002
Mo	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Na	0.7	0.8	0.7	0.8	1.6	1.7	1.8	1.9	0.8	1.0	1.6	1.5	1.6
Ni	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pb	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sb	ND	—	ND	—	ND	0.05	ND	ND	ND	ND	ND	ND	ND
Se	ND	—	ND	—	ND	0.08	ND	ND	ND	ND	ND	ND	ND
Si	2.8	3.0	2.4	2.9	1.0	3.9	3.9	3.7	2.8	2.8	3.8	3.6	3.7
Sn	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sr	0.027	0.028	0.025	0.028	0.052	0.052	0.052	0.058	0.030	0.029	0.046	0.043	0.045
Ti	0.050	0.037	0.029	0.030	ND	ND	ND	0.005	0.006	0.007	0.004	0.005	0.004
V	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zn	ND	ND	ND	ND	ND	0.035	ND	0.002	ND	ND	ND	ND	ND

Ext = Extractable
Tot = Total
Diss = Dissolved
ND = Not Detected

SURFACE WATER CHEMISTRY - METALS

FINN CREEK

Metal ($mg.L^{-1}$)	Sample Dates												
	Jun 03/81		Sep 30/81		Mar 04/82		Mar 31/82		Jun 08/82		Mar 15/83		
	Ext	Tot	Ext	Tot	Ext	Tot	Ext	Tot	Ext	Tot	Ext	Tot	Diss
Al	0.30	0.51	0.08	0.24	ND	ND	ND	0.05	0.21	0.23	0.80	0.10	0.06
As	ND	—	ND	—	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ba	0.003	0.004	0.003	0.003	0.003	0.004	0.005	0.005	0.003	0.003	0.004	0.003	0.003
Be	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ca	2.3	2.6	4.2	5.3	6.5	6.5	6.7	7.1	3.0	3.0	3.4	4.9	3.4
Cd	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Co	ND	—	ND	—	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cr	ND	ND	ND	ND	ND	0.008	ND	ND	ND	ND	ND	ND	ND
Cu	ND	ND	ND	0.006	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fe	0.176	0.432	0.529	0.714	0.027	0.074	0.037	0.129	0.112	0.110	0.054	0.064	0.028
Hg	ND	—	ND	—	ND	ND	ND	ND	ND	ND	ND	ND	ND
Mg	0.3	0.4	0.4	0.7	0.6	0.9	0.6	0.7	0.3	0.3	0.5	0.4	0.4
Mn	0.009	0.011	0.003	0.004	0.002	0.003	0.003	0.003	0.004	0.004	0.002	0.002	ND
Mo	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Na	ND	0.7	0.8	1.1	1.5	1.6	2.1	2.3	0.6	0.7	1.6	1.5	1.6
Ni	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pb	ND	ND	ND	ND	ND	0.02	ND	ND	ND	ND	ND	ND	ND
Sb	ND	—	ND	—	ND	0.06	ND	ND	ND	ND	ND	ND	ND
Se	ND	—	ND	—	ND	0.10	ND	ND	ND	ND	ND	ND	ND
Si	1.9	2.3	2.3	3.0	3.1	3.1	3.3	3.1	2.3	2.3	3.4	3.3	3.4
Sn	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sr	0.021	0.022	0.040	0.047	0.062	0.061	0.065	0.072	0.026	0.027	0.047	0.045	0.046
Ti	0.163	0.023	0.010	0.014	ND	ND	ND	0.002	0.003	0.005	0.003	0.003	0.004
V	ND	ND	ND	ND	ND	0.02	ND	ND	ND	ND	ND	ND	ND
Zn	ND	ND	ND	0.013	ND	ND	ND	0.004	ND	0.003	ND	ND	ND

Ext = Extractable
Tot = Total
Diss = Dissolved
ND = Not Detected

SURFACE WATER CHEMISTRY - METALS

HENDRIX LAKE

Metal	Sample Dates												
	Jun 02/81		Sep 30/81		Mar 03/82		Mar 30/82		Jun 11/82		Mar 16/83		
($mg.L^{-1}$)	Ext	Tot	Ext	Tot	Ext	Tot	Ext	Tot	Ext	Tot	Ext	Tot	Diss
Al	0.14	0.19	ND	0.10	ND	ND	ND	0.05	C.26	0.26	0.13	0.13	0.09
As	ND	—	ND	—	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ba	0.003	0.003	0.002	0.003	0.004	0.005	0.004	0.005	0.004	0.004	0.006	0.006	0.006
Be	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ca	5.0	4.9	6.8	7.6	7.9	8.0	9.6	10.0	5.3	5.1	5.9	5.7	6.0
Cd	ND	ND	ND	ND	ND	0.002	ND	ND	ND	ND	ND	ND	ND
Co	ND	—	ND	—	0.015	ND	ND	ND	ND	ND	ND	ND	ND
Cr	ND	ND	ND	ND	ND	0.022	ND	ND	ND	ND	ND	ND	ND
Cu	ND	ND	ND	ND	ND	0.013	ND	ND	ND	ND	ND	ND	ND
Fe	0.211	0.251	0.180	0.409	0.388	0.596	0.174	0.220	0.326	0.267	0.597	0.655	0.433
Hg	ND	—	ND	—	ND	ND	ND	ND	ND	ND	ND	ND	ND
Mg	1.2	1.2	1.4	1.6	2.0	2.3	2.3	2.4	1.3	1.2	2.2	2.1	2.2
Mn	0.011	0.013	0.010	0.014	0.024	0.025	0.009	0.010	0.014	0.011	0.066	0.064	0.065
Mo	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Na	0.7	0.7	0.8	1.0	1.0	1.3	1.3	1.4	0.7	0.8	1.3	1.2	1.3
Ni	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pb	ND	ND	ND	ND	ND	0.04	ND	ND	ND	ND	ND	ND	ND
Sb	ND	—	ND	—	ND	0.07	ND	ND	ND	ND	ND	ND	ND
Se	ND	—	ND	—	ND	0.09	ND	ND	ND	ND	ND	ND	ND
Si	3.2	3.4	2.2	2.8	3.1	3.1	3.6	3.5	3.9	3.6	4.5	4.3	4.5
Sn	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sr	0.020	0.020	0.025	0.028	0.031	0.031	0.038	0.040	0.020	0.019	0.031	0.030	0.031
Ti	0.011	0.011	0.007	0.013	ND	ND	ND	0.004	0.01	0.008	0.005	0.006	0.004
V	ND	ND	ND	ND	ND	0.02	ND	ND	ND	ND	ND	ND	ND
Zn	ND	0.005	ND	0.007	0.035	0.042	0.027	0.034	ND	ND	0.005	0.004	0.005

Ext = Extractable
Tot = Total
Diss = Dissolved
ND = Not Detected

SURFACE WATER CHEMISTRY - METALS

HORSEFLY RIVER

Metal	Sample Dates												
	Jun 02/81		Sep 30/81		Mar 02/82		Mar 30/82		Jun 11/82		Mar 16/83		
($mg.L^{-1}$)	Ext	Tot	Ext	Tot	Ext	Tot	Ext	Tot	Ext	Tot	Ext	Tot	Diss
Al	0.17	0.34	ND	0.11	ND	ND	ND	ND	0.29	0.43	ND	ND	ND
As	ND	--	ND	--	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ba	0.007	0.008	0.008	0.009	0.01	0.011	0.010	0.011	0.009	0.009	0.009	0.009	0.009
Be	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ca	5.8	6.0	8.5	9.8	12.2	12.0	12.6	12.7	5.7	5.6	12.4	12.1	12.3
Cd	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Co	ND	--	ND	—	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cr	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cu	ND	ND	ND	ND	ND	0.01	ND	ND	ND	ND	ND	ND	ND
Fe	0.235	0.599	0.0691	0.418	0.044	0.104	0.046	0.071	0.432	0.580	0.109	0.118	0.058
Hg	ND	--	ND	—	ND	ND	ND	ND	ND	ND	ND	ND	ND
Mg	0.9	1.0	1.2	1.5	2.1	2.4	1.8	1.9	0.9	1.0	1.8	1.7	1.8
Mn	0.011	0.014	0.005	0.007	0.007	0.007	0.005	0.005	0.017	0.018	0.008	0.007	0.006
Mo	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Na	ND	0.5	0.6	0.8	1.3	1.5	1.2	1.2	0.4	0.6	1.1	1.0	1.2
Ni	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pb	ND	ND	ND	ND	ND	0.03	ND	ND	ND	ND	ND	ND	ND
Sb	ND	—	ND	--	ND	0.07	ND	ND	ND	ND	ND	ND	ND
Se	ND	—	ND	—	ND	0.11	ND	ND	ND	ND	ND	ND	ND
Si	1.7	1.9	1.9	2.3	2.7	2.7	2.8	2.5	2.0	2.1	2.9	2.7	2.8
Sn	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sr	0.030	0.031	0.040	0.046	0.061	0.059	0.063	0.066	0.030	0.029	0.061	0.060	0.061
Ti	0.018	0.021	0.009	0.012	ND	ND	ND	ND	0.015	0.021	0.003	0.003	0.004
V	ND	ND	ND	ND	ND	0.01	ND	ND	ND	ND	ND	ND	ND
Zn	ND	0.006	ND	0.008	ND	0.005	ND	ND	ND	ND	0.002	ND	0.002

Ext = Extractable
Tot = Total
Diss = Dissolved
ND = Not Detected

SURFACE WATER CHEMISTRY - METALS

LOON CREEK

Metal ($mg.L^{-1}$)	Sample Dates Jun 01/81 Ext	Tot
Al	0.30	0.98
As	0.075	--
Ba	0.013	0.014
Be	ND	ND
Ca	18.5	18.6
Cd	ND	ND
Co	ND	—
Cr	ND	ND
Cu	ND	ND
Fe	0.440	1.100
Hg	ND	—
Mg	22.1	22.0
Mn	0.048	0.050
Mo	ND	ND
Na	21.9	20.9
Ni	ND	ND
Pb	ND	ND
Sb	ND	—
Se	ND	—
Si	10.5	12.4
Sn	ND	ND
Sr	0.077	0.078
Ti	0.018	0.064
V	ND	ND
Zn	ND	ND

Ext = Extractable
Tot = Total
ND = Not Detected

SURFACE WATER CHEMISTRY - METALS

LOUIS CREEK

Metal	Sample Dates	
	Jun 02/81	
($mg.L^{-1}$)	Ext	Tot
Al	0.90	2.39
As	ND	--
Ba	0.026	0.033
Be	ND	ND
Ca	28.3	28.0
Cd	ND	ND
Co	ND	--
Cr	ND	ND
Cu	0.011	0.012
Fe	1.810	3.720
Hg	ND	--
Mg	4.8	5.3
Mn	0.079	0.101
Mo	ND	ND
Na	1.5	1.6
Ni	ND	ND
Pb	ND	ND
Sb	ND	--
Se	ND	--
Si	5.8	8.3
Sn	ND	ND
Sr	0.149	0.150
Ti	0.047	0.142
V	ND	ND
Zn	0.007	0.014

Ext = Extractable
Tot = Total
ND = Not Detected

SURFACE WATER CHEMISTRY - METALS

LOWER SHUSWAP RIVER

Metal ($mg.L^{-1}$)	Sample Dates: Jun 04/81 Ext	Jun 04/81 Tot	Oct 01/81 Ext	Oct 01/81 Tot
Al	0.16	0.30	ND	0.07
As	ND	--	ND	--
Ba	0.010	0.010	0.008	0.009
Be	ND	ND	ND	ND
Ca	13.4	13.3	14.0	15.6
Cd	ND	ND	ND	ND
Co	ND	--	ND	--
Cr	ND	ND	ND	ND
Cu	ND	ND	ND	ND
Fe	0.179	0.293	0.025	0.293
Hg	ND	--	ND	--
Mg	1.7	1.7	1.6	1.8
Mn	0.006	0.008	0.001	0.002
Mo	ND	ND	ND	ND
Na	1.1	1.1	1.1	1.4
Ni	ND	ND	ND	ND
Pb	ND	ND	ND	ND
Sb	ND	--	ND	--
Se	ND	--	ND	--
Si	3.3	3.6	2.8	3.4
Sn	ND	ND	ND	ND
Sr	0.064	0.063	0.065	0.070
Ti	0.019	0.020	0.008	0.011
V	ND	ND	ND	ND
Zn	ND	0.007	ND	ND

Ext = Extractable
Tot = Total
ND = Not Detected

SURFACE WATER CHEMISTRY - METALS

McKINLEY LAKE

Metal ($mg.L^{-1}$)	Sample Dates: Jun 02/81 Ext	Jun 02/81 Tot	Sep 30/81 Ext	Sep 30/81 Tot
Al	0.17	0.32	0.12	0.17
As	ND	--	ND	--
Ba	0.008	0.008	0.009	0.009
Be	ND	ND	ND	ND
Ca	14.4	14.8	14.2	15.5
Cd	ND	ND	ND	ND
Co	ND	--	ND	--
Cr	ND	ND	ND	ND
Cu	ND	ND	ND	0.006
Fe	0.192	0.443	0.232	0.300
Hg	ND	--	ND	--
Mg	2.1	2.2	2.0	2.1
Mn	0.006	0.008	0.010	0.011
Mo	ND	ND	ND	ND
Na	1.3	1.3	1.2	1.1
Ni	ND	ND	ND	ND
Pb	ND	ND	ND	ND
Sb	ND	--	ND	--
Se	ND	--	ND	--
Si	3.2	3.5	2.7	3.2
Sn	ND	ND	ND	ND
Sr	0.074	0.074	0.070	0.076
Ti	0.016	0.021	0.019	0.020
V	ND	ND	ND	ND
Zn	ND	ND	ND	0.010

Ext = Extractable
Tot = Total
ND = Not Detected

SURFACE WATER CHEMISTRY - METALS

NICOLA RIVER

Metal ($mg.L^{-1}$)	Sample Dates Jun 05/81 Ext	Tot
Al	0.56	1.40
As	ND	--
Be	0.028	0.029
Be	ND	ND
Ca	26.5	27.3
Cd	ND	ND
Co	ND	--
Cr	ND	ND
Cu	ND	0.005
Fe	0.728	1.500
Hg	ND	--
Mg	9.04	9.5
Mn	0.052	0.059
Mo	ND	ND
Na	7.7	7.7
Ni	ND	ND
Pb	ND	ND
Sb	ND	--
Se	ND	--
Si	1.8	3.8
Sn	ND	ND
Sr	0.163	0.166
Ti	0.023	0.070
V	ND	ND
Zn	ND	ND

Ext = Extractable
Tot = Total
ND = Not Detected

SURFACE WATER CHEMISTRY - METALS

NORTH BARRIERE RIVER

Metal	Sample Dates													
	Jun 02/81		Oct 01/81		Mar 04/82		Mar 31/82		Jun 08/82		Mar 16/83			
($mg.L^{-1}$)	Ext	Tot	Ext	Tot	Ext	Tot	Ext	Tot	Ext	Tot	Ext	Tot	Diss
Al	0.11	0.18	ND	0.13	ND	ND	0.10	0.20	0.31	0.50	0.44	0.17	ND
As	ND	—	ND	—	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ba	0.005	0.005	0.005	0.006	0.009	0.010	0.011	0.012	0.009	0.010	0.015	0.024	0.009
Be	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ca	5.3	5.3	6.3	7.3	16.8	16.2	18.5	19.4	9.7	9.5	18.5	18.5	17.6
Cd	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Co	ND	—	ND	—	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cr	ND	ND	ND	ND	ND	0.006	ND	ND	ND	ND	ND	ND	ND
Cu	ND	ND	ND	ND	ND	0.008	ND	ND	ND	ND	ND	ND	ND
Fe	0.093	0.211	0.053	0.420	0.037	0.112	0.143	0.311	0.384	0.565	0.815	2.23	0.027
Hg	ND	—	ND	—	ND	ND	ND	ND	ND	ND	ND	ND	ND
Mg	0.8	0.8	1.0	1.3	3.8	4.0	4.2	4.6	1.9	1.8	4.2	4.5	3.9
Mn	0.005	0.008	0.003	0.004	0.003	0.003	0.006	0.008	0.014	0.015	0.031	0.046	0.004
Mo	ND	ND	ND	ND	ND	ND	0.005	ND	ND	ND	ND	ND	ND
Na	1.1	1.1	1.1	1.3	1.9	2.0	2.0	2.1	1.3	1.5	1.9	2.0	1.9
Ni	ND	ND	ND	ND	ND	ND	ND	0.02	ND	ND	ND	ND	ND
Pb	ND	ND	ND	ND	ND	ND	ND	0.02	ND	ND	ND	ND	ND
Sb	ND	—	ND	—	ND	0.06	ND	ND	ND	ND	ND	ND	ND
Se	ND	—	ND	—	ND	0.09	ND	ND	ND	ND	ND	ND	ND
Si	3.2	3.5	3.0	4.2	4.3	4.0	4.3	4.2	4.4	4.5	5.1	7.3	4.4
Sn	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sr	0.027	0.027	0.031	0.035	0.088	0.086	0.095	0.106	0.050	0.05	0.092	0.092	0.089
Ti	0.011	0.012	0.008	0.013	ND	ND	0.007	0.012	0.012	0.036	0.022	0.187	0.004
V	ND	ND	ND	ND	ND	0.01	ND	ND	ND	ND	ND	ND	ND
Zn	ND	ND	ND	ND	0.002	0.006	ND	0.009	ND	ND	0.002	0.003	ND

Ext = Extractable
Tot = Total
Diss = Dissolved
ND = Not Detected

SURFACE WATER CHEMISTRY - METALS

RAPT RIVER

Metal	Sample Dates												
	Jun 02/81		Oct 01/81		Mar 04/82		Mar 31/82		Jun 09/82		Mar 14/83		
($mg.L^{-1}$)	Ext	Tot	Ext	Tot	Ext	Tot	Ext	Tot	Ext	Tot	Ext	Tot	Diss
Al	0.47	1.10	0.07	0.13	ND	ND	ND	0.06	0.56	0.82	0.11	0.20	0.05
As	ND	--	ND	--	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ba	0.009	0.013	0.009	0.009	0.012	0.013	0.014	0.016	0.010	0.012	0.011	0.011	0.01
Be	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ca	3.3	3.9	6.6	7.4	10.5	10.4	10.9	11.1	3.7	3.7	8.6	8.3	8.4
Cd	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Co	ND	—	ND	—	0.006	ND	ND	ND	ND	ND	ND	ND	ND
Cr	ND	ND	ND	ND	ND	0.017	ND	ND	ND	ND	ND	ND	ND
Cu	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fe	0.452	1.120	0.136	0.352	0.182	0.339	0.252	0.283	0.539	0.734	0.211	0.299	0.115
Hg	ND	—	ND	—	ND	ND	ND	ND	ND	ND	ND	ND	ND
Mg	0.6	0.8	1.1	1.3	2.1	2.4	2.2	2.3	0.7	0.7	1.5	1.4	1.4
Mn	0.021	0.043	0.011	0.013	0.018	0.019	0.017	0.017	0.019	0.022	0.017	0.017	0.012
Mo	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Na	0.8	1.1	1.5	1.7	2.6	2.7	2.8	2.7	0.8	0.9	1.9	1.9	2.0
Ni	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pb	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sb	ND	--	ND	—	ND	0.06	ND	ND	ND	ND	ND	ND	ND
Se	ND	--	ND	—	ND	0.08	ND	ND	ND	ND	ND	ND	ND
Si	2.8	4.0	3.2	3.7	4.3	4.2	4.6	4.2	3.3	3.6	4.4	4.4	4.3
Sn	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sr	0.024	0.028	0.050	0.055	0.085	0.086	0.092	0.098	0.026	0.027	0.064	0.062	0.062
Ti	0.031	0.051	0.009	0.013	ND	ND	0.003	0.005	0.028	0.036	0.006	0.009	0.005
V	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zn	ND	0.013	ND	0.009	ND	ND	ND	0.002	0.042	ND	ND	ND	0.002

Ext = Extractable
Tot = Total
Diss = Dissolved
ND = Not Detected

SURFACE WATER CHEMISTRY - METALS

SETON RIVER

Metal ($mg.L^{-1}$)	Sample Dates: Jun 01/81 Ext	Jun 01/81 Tot	Sep 29/81 Ext	Sep 29/81 Tot
Al	0.70	2.43	0.11	0.19
As	ND	--	ND	--
Ba	0.018	0.003	0.012	0.012
Be	ND	ND	ND	ND
Ca	12.0	12.9	11.1	12.4
Cd	ND	ND	ND	ND
Co	ND	—	ND	—
Cr	ND	0.008	ND	ND
Cu	ND	0.006	ND	ND
Fe	1.180	3.400	0.102	0.395
Hg	ND	—	ND	—
Mg	1.8	2.7	2.1	2.5
Mn	0.055	0.089	0.004	0.005
Mo	ND	ND	ND	ND
Na	1.1	1.2	1.4	1.7
Ni	ND	ND	ND	ND
Pb	ND	ND	ND	ND
Sb	ND	--	ND	--
Se	ND	--	ND	—
Si	3.0	5.4	2.2	2.7
Sn	ND	ND	ND	ND
Sr	0.064	0.067	0.060	0.065
Ti	0.039	0.138	0.016	0.018
V	ND	ND	ND	ND
Zn	ND	0.010	ND	ND

Ext = Extractable
Tot = Total
ND = Not Detected

SURFACE WATER CHEMISTRY - METALS

SEYMOUR RIVER

Metal	Sample Dates								
	Jun 03/81		Oct 01/81		Jun 10/82		Mar 16/83		
($mg.L^{-1}$)	Ext	Tot	Ext	Tot	Ext	Tot	Ext	Tot	Diss
Al	0.39	0.44	0.31	0.41	0.24	0.31	0.08	0.06	0.06
As	ND	--	ND	--	ND	ND	ND	ND	ND
Ba	0.007	0.008	0.008	0.008	0.006	0.006	0.006	0.006	0.005
Be	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ca	3.0	3.0	4.1	4.6	3.4	3.5	5.6	5.5	5.5
Cd	ND	ND	ND	ND	ND	ND	ND	ND	ND
Co	ND	--	ND	--	ND	ND	ND	ND	ND
Cr	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cu	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fe	0.354	0.390	0.368	0.486	0.243	0.239	0.155	0.152	0.109
Hg	ND	--	ND	--	ND	ND	ND	ND	ND
Mg	0.4	0.4	0.5	0.5	0.4	0.4	0.6	0.5	0.6
Mn	0.007	0.008	0.009	0.012	0.005	0.004	0.005	0.004	0.005
Mo	ND	ND	ND	ND	ND	ND	ND	ND	ND
Na	ND	ND	ND	0.5	0.3	0.6	0.9	0.8	0.9
Ni	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pb	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sb	ND	--	ND	--	ND	ND	ND	ND	ND
Se	ND	--	ND	--	ND	ND	ND	ND	ND
Si	1.9	2.2	2.2	2.7	2.1	2.1	5.6	3.0	5.5
Sn	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sr	0.016	0.016	0.020	0.021	0.018	0.017	0.028	0.027	0.028
Ti	0.041	0.038	0.036	0.039	0.020	0.020	0.004	0.004	0.004
V	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zn	ND	ND	ND	0.006	ND	0.002	ND	ND	ND

Ext = Extractable
Tot = Total
Diss = Dissolved
ND = Not Detected

APPENDIX 3a

SNOWMELT CHEMISTRY - METALS, 1982

ADAMS RIVER AREA, (below Adams Lake) MARCH 5, 1982

Total Metals ($mg.L^{-1}$)	Replicates 1	2	3
Al	0.07	ND	0.08
As	ND	ND	ND
Ba	0.001	0.001	0.001
Be	ND	ND	ND
Ca	0.3	0.3	0.3
Cd	ND	ND	ND
Co	ND	ND	ND
Cr	ND	ND	ND
Cu	ND	ND	ND
Fe	0.114	0.113	0.123
Hg	ND	ND	ND
Mg	ND	ND	ND
Mn	0.005	0.005	0.004
Mo	ND	ND	ND
Na	ND	ND	ND
Ni	ND	ND	ND
P	ND	ND	ND
Pb	ND	ND	ND
Sb	ND	ND	ND
Se	ND	ND	ND
Si	0.3	ND	0.1
Sn	ND	ND	ND
Sr	ND	0.001	0.001
Ti	0.003	0.005	0.004
V	ND	ND	ND
Zn	ND	ND	0.005

ND = Not Detected

SNOWMELT CHEMISTRY - METALS, 1982

EAGLE RIVER AREA, MARCH 5, 1982

Total Metals ($mg.L^{-1}$)	Replicates 1	2	3
Al	ND	ND	ND
As	ND	ND	ND
Ba	0.002	0.003	0.001
Be	ND	ND	ND
Ca	0.2	0.5	0.2
Cd	ND	ND	ND
Co	ND	ND	ND
Cr	ND	ND	ND
Cu	ND	ND	ND
Fe	0.159	0.09	0.096
Hg	ND	ND	ND
Mg	ND	ND	ND
Mn	0.003	0.01	0.003
Mo	ND	ND	ND
Na	ND	ND	ND
Ni	ND	ND	ND
P	ND	0.07	ND
Pb	ND	ND	ND
Sb	ND	ND	ND
Se	ND	ND	ND
Si	ND	ND	ND
Sn	ND	ND	ND
Sr	0.001	0.003	ND
Ti	0.005	ND	ND
V	ND	ND	ND
Zn	0.009	ND	ND

ND = Not Detected

SNOWMELT CHEMISTRY - METALS, 1982

FINN CREEK AREA, MARCH 4, 1982

Total Metals ($mg.L^{-1}$)	Replicates 1	2	3
Al	ND	ND	ND
As	ND	ND	ND
Ba	ND	ND	ND
Be	ND	ND	ND
Ca	ND	ND	ND
Cd	ND	ND	ND
Co	ND	ND	ND
Cr	ND	0.006	ND
Cu	ND	ND	ND
Fe	0.05	0.08	0.046
Hg	ND	ND	ND
Mg	ND	ND	ND
Mn	0.002	0.002	0.002
Mo	ND	ND	ND
Na	ND	ND	ND
Ni	ND	ND	ND
P	ND	ND	ND
Pb	ND	ND	ND
Sb	ND	ND	ND
Se	ND	ND	ND
Si	ND	ND	ND
Sn	ND	ND	ND
Sr	ND	ND	ND
Ti	0.004	0.005	0.004
V	ND	ND	ND
Zn	ND	0.014	ND

ND = Not Detected

SNOWMELT CHEMISTRY - METALS, 1982

HORSEFLY RIVER AREA, MARCH 2, 1982

Total Metals ($mg.L^{-1}$)	Replicates 1	2	3
Al	ND	ND	ND
As	ND	ND	ND
Ba	ND	ND	0.004
Be	ND	ND	ND
Ca	0.1	ND	0.3
Cd	ND	ND	ND
Co	ND	ND	ND
Cr	ND	ND	ND
Cu	ND	ND	ND
Fe	0.011	0.024	0.035
Hg	ND	ND	ND
Mg	ND	ND	ND
Mn	0.006	ND	0.066
Mo	ND	ND	ND
Na	ND	ND	ND
Ni	ND	ND	ND
P	ND	ND	ND
Pb	ND	ND	ND
Sb	ND	ND	ND
Se	ND	ND	ND
Si	ND	ND	ND
Sn	ND	ND	ND
Sr	ND	ND	ND
Ti	0.002	0.003	0.004
V	ND	ND	ND
Zn	0.012	ND	0.018

ND = Not Detected

SNOWMELT CHEMISTRY - METALS, 1982

RAFT RIVER AREA, MARCH 4, 1982

Total Metals ($mg.L^{-1}$)	Replicates 1	2	3
Al	0.1	0.07	0.11
As	ND	ND	ND
Ba	0.003	0.003	0.007
Be	ND	ND	ND
Ca	0.3	0.2	1.2
Cd	ND	ND	ND
Co	ND	ND	ND
Cr	ND	ND	ND
Cu	ND	ND	ND
Fe	0.137	0.092	0.131
Hg	ND	ND	ND
Mg	ND	ND	0.1
Mn	0.009	0.008	0.032
Mo	ND	ND	ND
Na	0.3	0.3	0.2
Ni	ND	ND	ND
P	ND	ND	0.06
Pb	ND	ND	ND
Sb	ND	ND	ND
Se	ND	ND	ND
Si	ND	ND	ND
Sn	ND	ND	ND
Sr	0.002	0.001	0.006
Ti	0.009	0.006	0.008
V	ND	ND	ND
Zn	ND	0.004	0.004

ND = Not Detected

APPENDIX 3b

SNOWMELT CHEMISTRY - METALS, 1983

ADAMS RIVER AREA, (above lake) MARCH 16, 1983

Metal	Replicates 1			2		
($mg.L^{-1}$)	Ext	Tot	Diss	Ext	Tot	Diss
Al						
As				ND	ND	ND
Ba				ND	ND	ND
Be				ND	ND	ND
Ca				ND	ND	ND
Cd				ND	ND	ND
Co				ND	ND	ND
Cr				ND	ND	ND
Cu				ND	ND	ND
Fe				0.006	0.017	ND
Hg				ND	ND	ND
Mg				ND	ND	ND
Mn				ND	ND	ND
Mo				ND	ND	ND
Na				ND	ND	0.3
Ni				ND	ND	ND
Pb				ND	ND	ND
Sb				ND	ND	ND
Se				ND	ND	ND
Si				ND	ND	ND
Sn				ND	ND	ND
Sr				ND	ND	ND
Ti				0.002	0.002	ND
V				ND	ND	ND
Zn				ND	ND	ND

Ext = Extractable
Tot = Total
Diss = Dissolved
ND = Not Detected

SNOWMELT CHEMISTRY - METALS, 1983

BLUE RIVER AREA, MARCH 15, 1983

Metal	Replicates 1			2		
($mg.L^{-1}$)	Ext	Tot	Diss	Ext	Tot	Diss
Al	ND	0.08	ND	ND	ND	ND
As	ND	ND	ND	ND	ND	ND
Ba	0.002	0.002	0.002	0.002	0.002	0.003
Be	ND	ND	ND	ND	ND	ND
Ca	ND	0.2	0.4	0.2	ND	0.3
Cd	ND	ND	ND	ND	ND	ND
Co	ND	ND	ND	ND	ND	ND
Cr	ND	ND	ND	ND	ND	ND
Cu	ND	ND	ND	ND	ND	ND
Fe	0.037	0.081	0.005	0.041	0.089	0.007
Hg	-	ND	-	ND	ND	ND
Mg	ND	ND	ND	ND	ND	ND
Mn	0.001	0.002	0.001	0.001	0.002	ND
Mo	ND	ND	ND	ND	ND	ND
Na	0.2	0.3	0.6	0.3	0.3	0.5
Ni	ND	ND	ND	ND	ND	ND
Pb	ND	ND	ND	ND	ND	ND
Sb	ND	ND	ND	ND	ND	ND
Se	ND	ND	ND	ND	ND	ND
Si	ND	0.1	ND	ND	ND	ND
Sn	ND	ND	ND	ND	ND	ND
Sr	ND	ND	ND	0.001	ND	ND
Ti	ND	0.002	ND	ND	0.004	ND
V	ND	ND	ND	ND	ND	ND
Zn	0.004	ND	ND	0.003	ND	ND

Ext = Extractable
Tot = Total
Diss = Dissolved
ND = Not Detected

SNOWMELT CHEMISTRY - METALS, 1983

BOSS CREEK AREA, MARCH 16, 1983

Metal	Replicates 1			2		
($mg.L^{-1}$)	Ext	Tot	Diss	Ext	Tot	Diss
Al						
As	ND	ND	ND	ND	ND	ND
Ba	ND	ND	0.002	ND	ND	0.001
Be	ND	ND	ND	ND	ND	ND
Ca	ND	ND	0.1	ND	ND	ND
Cd	ND	ND	ND	ND	ND	ND
Co	ND	ND	ND	ND	ND	ND
Cr	ND	ND	ND	ND	ND	ND
Cu	ND	ND	ND	ND	ND	ND
Fe	0.015	0.096	ND	0.008	0.013	ND
Hg	ND	ND	ND	ND	ND	ND
Mg	ND	ND	ND	ND	ND	ND
Mn	ND	0.001	ND	ND	ND	ND
Mo	ND	ND	ND	ND	ND	ND
Na	ND	ND	0.3	ND	ND	ND
Ni	ND	ND	ND	ND	ND	ND
Pb	ND	ND	ND	ND	ND	ND
Sb	ND	ND	ND	ND	ND	ND
Se	ND	ND	ND	ND	ND	ND
Si	ND	ND	ND	ND	ND	ND
Sn	ND	ND	ND	ND	ND	ND
Sr	ND	ND	ND	ND	ND	ND
Ti	ND	0.003	ND	ND	ND	ND
V	ND	ND	ND	ND	ND	ND
Zn	ND	ND	ND	ND	ND	ND

Ext = Extractable
Tot = Total
Diss = Dissolved
ND = Not Detected

SNOWMELT CHEMISTRY - METALS, 1983

HORSEFLY RIVER AREA, MARCH 16, 1983

Metal	Replicates 1			2		
($mg.L^{-1}$)	Ext	Tot	Diss	Ext	Tot	Diss
Al						
As				ND	ND	ND
Ba				ND	ND	0.001
Be				ND	ND	ND
Ca				ND	ND	ND
Cd				ND	ND	ND
Co				ND	ND	ND
Cr				ND	ND	ND
Cu				ND	ND	ND
Fe				0.015	0.032	ND
Hg				ND	ND	ND
Mg				ND	ND	ND
Mn				0.002	0.002	ND
Mo				ND	ND	ND
Na				ND	ND	ND
Ni				ND	ND	ND
Pb				ND	ND	ND
Sb				ND	ND	ND
Se				ND	ND	ND
Si				ND	ND	ND
Sn				ND	ND	ND
Sr				ND	ND	ND
Ti				ND	0.003	ND
V				ND	ND	ND
Zn				0.003	ND	ND

Ext = Extractable
Tot = Total
Diss = Dissolved
ND = Not Detected

SNOWMELT CHEMISTRY - METALS, 1983

SEYMOUR RIVER AREA, MARCH 16, 1983

Parameter	Replicates					
	1			2		
($mg.L^{-1}$)	Ext	Tot	Diss	Ext	Tot	Diss
Al						
As	ND	ND	ND	ND	ND	ND
Ba	ND	ND	ND	ND	ND	ND
Be	ND	ND	ND	ND	ND	ND
Ca	ND	ND	ND	ND	ND	ND
Cd	ND	ND	ND	ND	ND	ND
Co	ND	ND	ND	ND	ND	ND
Cr	ND	ND	ND	ND	ND	ND
Cu	ND	ND	ND	ND	ND	ND
Fe	0.005	0.014	ND	0.008	0.018	0.007
Hg	ND	ND	ND	ND	ND	ND
Mg	ND	ND	ND	ND	ND	ND
Mn	ND	ND	ND	ND	ND	ND
Mo	ND	ND	ND	ND	ND	0.2
Na	ND	ND	ND	ND	ND	ND
Ni	ND	ND	ND	ND	ND	ND
Pb	ND	ND	ND	ND	ND	ND
Sb	ND	ND	ND	ND	ND	ND
Se	ND	ND	ND	ND	ND	ND
Si	ND	ND	ND	ND	ND	ND
Sn	ND	ND	ND	ND	ND	ND
Sr	ND	ND	ND	ND	ND	ND
Ti	ND	ND	ND	ND	ND	ND
V	ND	ND	ND	ND	ND	ND
Zn	ND	ND	ND	ND	ND	ND

Ext = Extractable
Tot = Total
Diss = Dissolved
ND = Not Detected